SEPTEMBER, 1959
No. 240

ASTM Bulletin

Technical Committees Report Progress
See You in San Francisco!
Basic Research in Fatigue of Metals

American Society for Testing Materials

RESEARCH AND STANDARDS FOR MATERIALS

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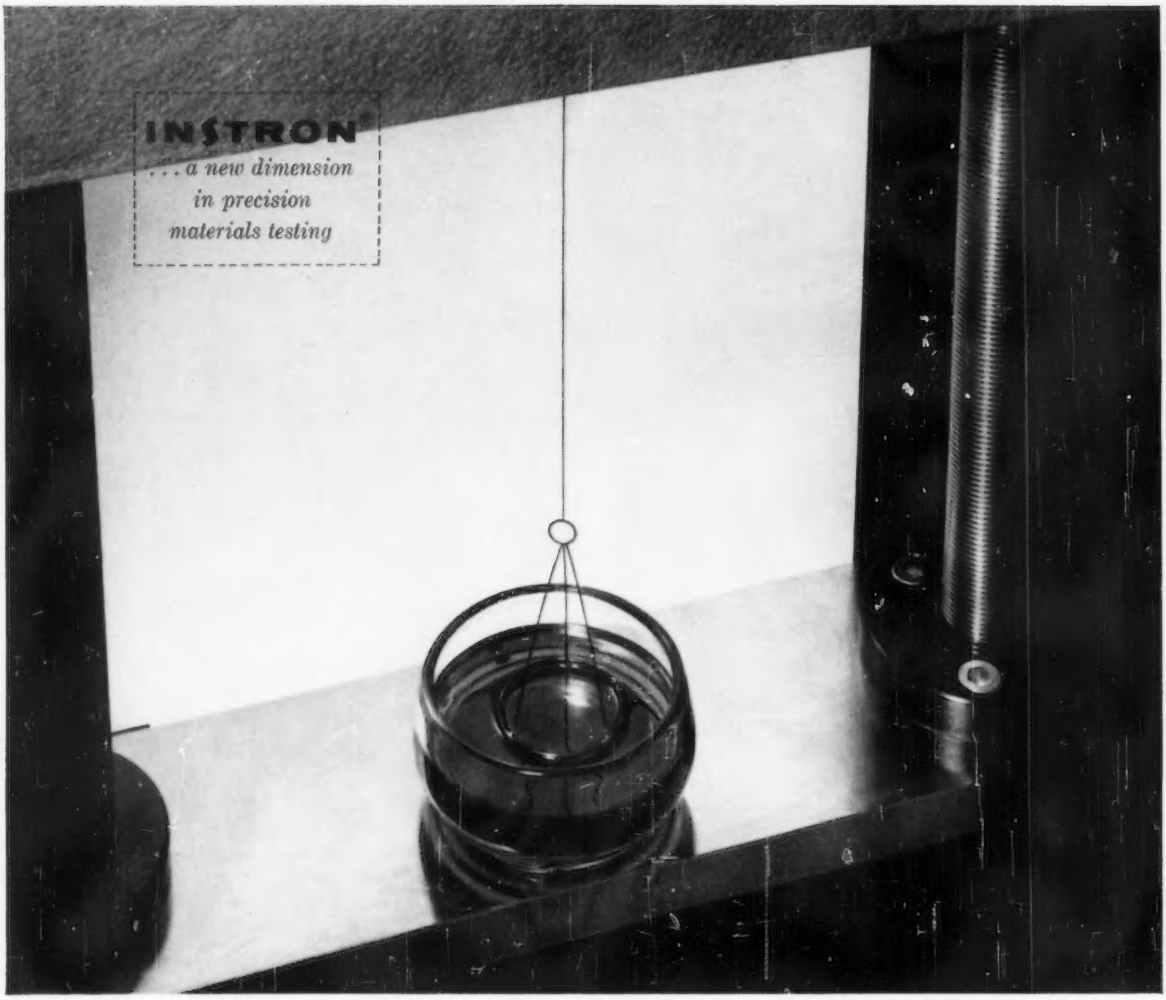

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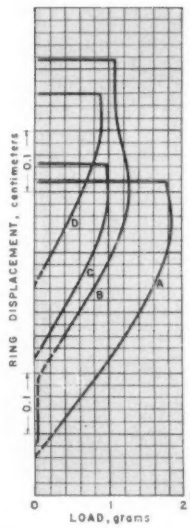

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September 1959 **Number 240**

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TECHNICAL PAPERS

Measurement Problems in the Instrument and Laboratory Apparatus Fields—E. L. Ruh, J. J. Moran, and R. D. Thompson. *There is a need to standardize on systems of measurement based on fundamental principles* 31

Cryogenic Engineering of Hydrogen Bubble Chambers—B. W. Birmingham, D. B. Chelton, D. B. Mann, and H. P. Hernandez. *Low-temperature material problems encountered during the development of a liquid-hydrogen bubble chamber are described* 34

Residual Stresses in Heat-Exchanger Tubes—*Technical Note* by G. A. Nelson 39

Water-Retardant Qualities of External Coatings—I. Soroka. *Test procedure proves satisfactory when used on 13 different coatings* 40

Discussion of a Paper on a Method of Test for Potential Efflorescence of Masonry Mortar—Leo Kampf 45

Low-Temperature Tensile Properties of Copper and Four Bronzes—R. M. McClintock, D. A. Van Gundy, and R. H. Kropschot. *At temperatures between 20 and 300 K, the tensile strength, yield strength, modulus of elasticity, and ductility of these materials generally increased with decreasing temperature* 47

A New Steel for Aircraft and Missile Honeycombs—*Technical Note* by Allen C. Gilbraith 51

Municipal Incinerator Refractories Practice—R. B. Engdahl and J. D. Sullivan. *Use of available refractories in municipal incinerators is described. ASTM specifications and test methods for refractories are discussed* 52

RESEARCH AND STANDARDS IN ACTION

Technical Committees Report Progress **5**

Why Don't Engineers Learn to Write?—Excerpt from an Address by Eric Walker **20**

See You in San Francisco!—Third Pacific Area National Meeting **21**

Basic Research in Fatigue of Metals—Thomas J. Dolan **24**

What Materials Will We Need in 1970? **28**

Advertising—Its Importance to the Technical Man **57**

DEPARTMENTS

ACR Notes	30	Material Questions	13
Actions on Standards	15	New ASTM Publications	16
Bookshelf	66	New Members	70
Coming Technical Papers	17	News of Members	84
Deaths	91	Other Societies' Events	80
District Activities	18	OTS Reports	76
Editorial	14	Random Samples	61
Government Standard Changes	100	Schedule of ASTM Meetings	15
Index to Advertisers	103	Your Committee Officers	25
Laboratory Supplies & Equipment	94		

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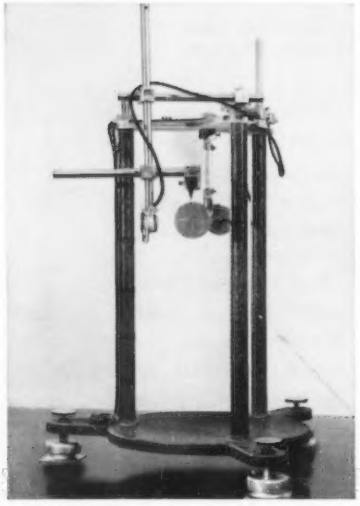

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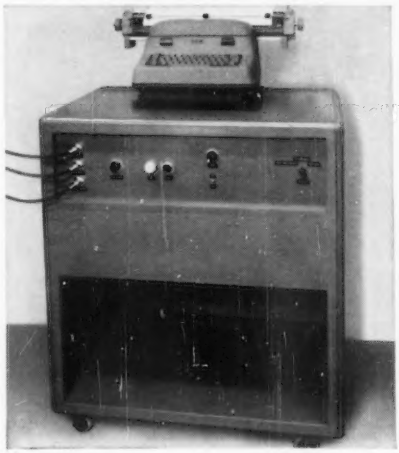

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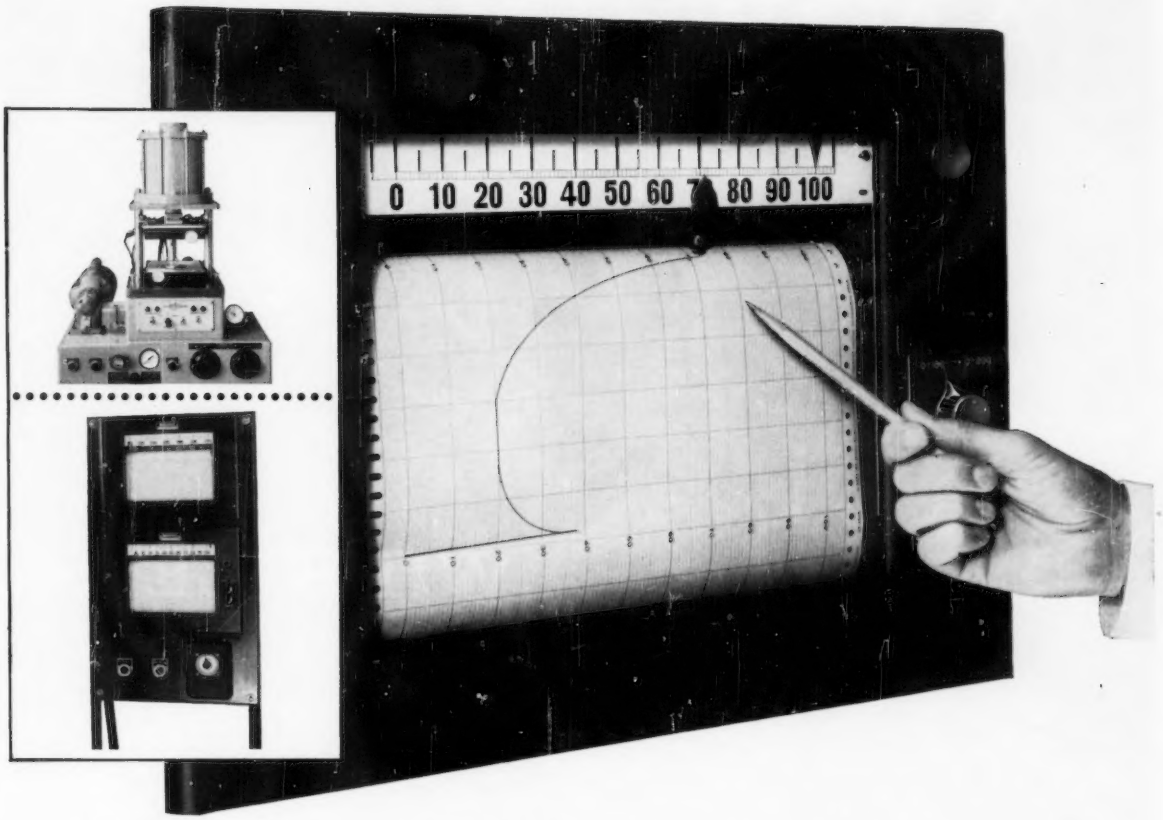

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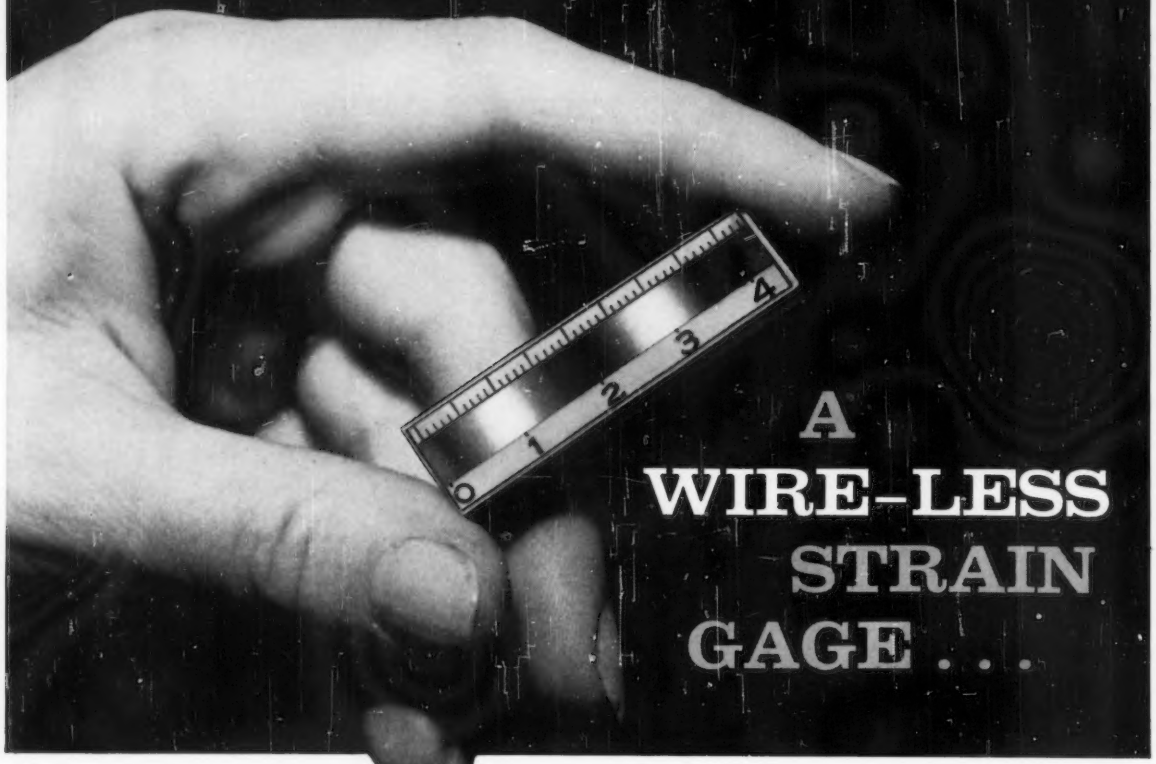

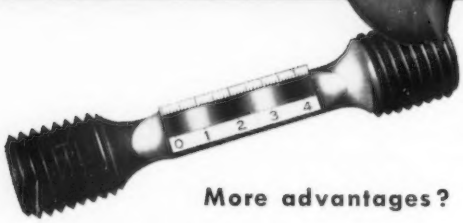

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ASTM BULLETIN

Research and Standards for Materials

Number 240 **September 1959**

Technical Committees Report Progress

ASTM is continually reshaping the great body of materials standards and test methods for which it is responsible. This work, always Number One in the Society's order of business, was pushed forward at more than 900 meetings of committees and subgroups at the Annual Meeting last June. A sampling of the committee activities follows.

Metals

Steel (A-1)

The minimum specified yield point for structural steel in specification A 7 may be raised. This steel has been the basic product for the structural steel industry for nearly 60 years. The present specified minimum yield point of 33,000 psi has remained unchanged since 1936, when it was raised from the value of 30,000 psi first specified in 1924. Before 1924, the yield point was specified as one-half the tensile strength, with a minimum tensile strength of 55,000 psi required. The American Institute of Steel Construction, the American Association of State Highway Officials, and Committee 15 of the Association of American Railroads will be asked whether they would use higher design stresses if such a step is taken. If so, a proposal for raising the minimum specified yield point of A 7 steel will be made at the next meeting of Committee A-1.

An extensive revision of the present requirements for removal of defects from structural shapes by chipping, grinding, and depositing weld metal is being balloted in subcommittee. In this proposed revision, reduction of thickness before welding is permitted up to 30 per cent of the nominal thickness at the location of the imperfection, with a maximum depth of depression set at $\frac{1}{2}$ in. Also additional provisions are included for toes of angles, beams, channels, and zees, and stems and toes of tees.

The Bureau of Public Roads has requested a test for yield strength in Specifications A 82 and A 185 for wire and wire fabric for concrete reinforcement, in place of the present yield point by drop of beam. Such a yield strength test is being incorporated in similar specifications for wire and fabric for governmental use. Committee A-1 action, which has been coordinated with the Bureau of Public Roads, the General Services Administration, and the American Association of State Highway Officials, will change the physical property requirements. A yield strength requirement at 0.5 per cent extension under load will replace the previous requirement for yield point by drop of beam. The test for yield strength need not necessarily be conducted by the manufacturer; it may be performed by the purchaser if he so desires.

Corrosion of Iron and Steel (A-5)

Two new specifications to cover the two types of commercially produced aluminum-coated steel sheets are in preparation. A study of methods to determine the porosity and uniformity of aluminum coatings on steel was begun. Procedures for stripping aluminum coatings from steel using reagents other than the caustic and acid of Method A 428 were also discussed.

A new atmospheric exposure program will compare performance of roofing sheets galvanized by the continuous line process and the individually dipped process at two coating weights. Aluminum-coated sheets will also be included. An atmospheric exposure program covering commercial grades of aluminum coated wire in farm field fencing, chain link fencing, barbed wire, and strand was also approved.

Progress is being made on specifications for galvanized sheets of structural quality, galvanized culvert sheets, aluminum coated steel sheets, copper-covered steel wire strand, and zinc-coated flat armor tape.

Malleable-Iron Castings (A-7)

Provisions for elevated-temperature use of standard and pearlitic malleables will be included in Specifications A 47 and A 220.

Atmospheric corrosion test plates of malleable iron at Kure Beach, N. C., have been removed, after a year's exposure. Plates at four other sites will be removed this summer to complete the first-year group of the 1, 3, 7, and 12-year exposure test series.

Non-Ferrous Metals and Alloys (B-2)

New task groups are being formed to prepare specifications for reactor grade sodium and for cast and wrought zinc anodes for electrogalvanic protection on ferrous products. Specifications for zirconium, molybdenum, and columbium are near final form. Others for beryllium, lithium, tantalum, and thorium are in preliminary draft form.

A Symposium on Solders and Soldering is being planned for the 1961 Annual Meeting. A three session Symposium on Newer Metals has been prepared for Oct. 15 and 16, 1959, in San Francisco, during the Third Pacific Area National Meeting.

Corrosion of Non-Ferrous Metals and Alloys (B-3)

An appendix to the 1959 Annual Report of Committee B-3 will report the relative corrosivity, in terms of the rate of corrosion of zinc and steel specimens, of many ASTM and other test sites in the United States and Canada. A new program to determine the relative corrosivity of 30 atmospheric corrosion test sites, including those not in the original study, was authorized. The zinc and steel specimens for this new study will be exposed in 1960.

The Task Group on the Measurement of Atmospheric Factors Effecting the Corrosion of Metals presented the data thus far accumulated on sulfur dioxide in the atmosphere using the lead peroxide method. A correlation was found between the rate of corrosion of a steel sample based on days of wetness with the measured temperature of the sample and the sulfur dioxide atmospheric pollution rate. The final report of this work will appear in a forthcoming issue of the BULLETIN.

Technical Committees

Nondestructive Testing (E-7)

A new set of reference radiographs for aluminum and magnesium castings has been prepared from specimens made expressly for this purpose. This effort is a joint ASTM-Aerospace Industries Assn. venture. The reference radiographs are expected to be published by ASTM in a few months. All sets of the radiographs will be composed of actual radiographs of the cast specimens, which will be retained by ASTM.

The committee is giving final consideration to a proposed method for dye-penetrant and fluorescent-penetrant inspection procedures.

Fatigue (E-9)

A revised set of definitions and symbols relating to fatigue testing and to the statistical analysis of fatigue data has been approved by Committee E-9. These revisions, compiled by a task group under the chairmanship of G. R. Gohn, of Bell Telephone Laboratories, Inc., replace Section II of the "Manual on Fatigue Testing," *STP 91* and also supersede the definitions now published in the supplement, *STP 91-A*. This completes the first step in a long-range program to revise the manual completely.

Effect of Temperature on the Properties of Metals (Joint ASTM-ASME)

Not long ago, the Materials Advisory Board of the National Academy of Sciences requested that ASTM undertake a project to standardize tension testing procedures for metallic materials at elevated temperatures under conditions of rapid loading and heating. The need: methods that could be used for certification, capability, quality control, and acceptance testing of materials for airframes and missiles.

The problem was referred to the ASTM-ASME joint committee who, in less than a year's time from the original request developed the following recommended practices:

(1) Tension Tests of Metallic Materials at Elevated Temperatures with Rapid Heating and Conventional or Rapid Strain Rates.

(2) Conducting Creep and Creep-Rupture Tension Tests of Metallic Materials under Conditions of Rapid Heating and Short Times.

These documents were drafted by a task force headed by R. W. Fenn, Jr., of Dow Chemical Co., with representation from the Aerospace Industries Assn. through its Aircraft Research and Testing Committee. They were approved at the Annual Meeting in June by the Test Methods Panel, J. W. Freeman, University of Michigan, chairman. Following the Annual Meeting, these methods were approved by committee letter ballot. They will be published this fall in Part 3 of the 1959 Supplement to the Book of ASTM Standards.

Construction Materials

Cement (C-1)

The nonstaining properties of cement with respect to limestone can be analyzed by a new method involving the amount of water-soluble "alkali" in masonry cement by means of the flame photometer. This method is being considered by Committee C-1. Also under consideration is a change in the procedure for determining the autoclave expansion of masonry cement. Early stiffening in cement paste can be determined by a new method now being prepared. A procedure for the mechanical mixing of cement paste used in various acceptance tests is in the process of adoption.

The relationship between strengths of 2-in. mortar cubes and the flexural and compressive strengths of mortar prisms has been studied using two cements at nine laboratories. Important changes in the Test for Compressive Strength of Hydraulic Cement Mortars (C 349) are contemplated as the result of this study. The very extensive study given to the use of sulfur trioxide has resulted in a proposed change in the Specification for Portland Cement (C 150) to permit the use of an optimum amount in manufacture.

The need for a special procedure for determining the alkalies in cements having a high alkali content is being studied. Nonharmful additions used in the manufacture of portland cement will be controlled by a proposed specification now in preparation. A clarification of the concept of workability of cement paste and mortars is also being prepared.

Clay Pipe (C-4)

Clay liner plates will now be covered by a specification which is approaching final form. This specification includes vitrified clay liner plates to be used in lining or facing pipe, culverts, abutments, and other structures subject to corrosion or erosion due to acid, alkali, scouring waste water, or other liquids. A newly completed specification for extra-strength perforated clay pipe will be either incorporated into the existing Specification for Standard Strength Perforated Clay Pipe (C 211) or be published separately.

New Committee C-24 on Elastomeric Sealants is Organized

THE SEALING of joints in many types of construction, be it aircraft, building, or highway, is a growing problem for the architect, engineer, designer, and contractor. The reliance on sealants and caulking compounds has increased greatly since the advent of component construction. The many types of curtain-wall constructions rely on sealants or gaskets to preserve their weather tightness under all conditions. This has presented a challenge to the manufacturers of materials for this purpose. Such materials must not only be resistant to weathering but must be resilient, adhesive, nonstaining, and permit ease and economy of installation.

This has led to the need for standards of quality. Cognizant of this need, the Board of Directors, at its May meeting, authorized a new technical committee, C-24 on Elastomeric Sealants. It was recognized there would be need for coordination with other technical committees of the Society, including Committees D-1 on Paint, Varnish, Lacquer and Related Materials and D-11 on Rubber and Rubber-like Materials.

Plans for organization of this new committee have proceeded rapidly. A steering committee met on June 10, with D. E. Parsons, National Bureau of Standards, being elected as temporary chairman. A proposed scope was approved which reads as follows:

"The promotion of knowledge, stimulation of research and the development of methods of test, specifications, and nomenclature of elastomeric materials for use by the construction industry for sealing joints. Such sealants include caulking and glazing compounds and preformed gaskets and tapes."

The organization meeting was held on September 15 at ASTM Headquarters in Philadelphia. A full report of this meeting will be given in the next issue of the BULLETIN.

Any organization or individual interested in participating should get in touch with ASTM Headquarters.

Revisions of the requirements for pipe joints were accepted in the Specification for Vitrified Clay Pipe Joints Using Materials Having Resilient Properties (C 425). The committee will now consider the matter of separating references to ceramic glazed clay pipe in Specifications C 261 and C 278 with separate specifications now to be developed for standard and extra-strength ceramic glazed clay pipe. It was further recommended that the present crushing strength requirements of Specification C 261 be made identical with the requirements of Specification C 13 and that the dimensions and crushing strengths of the proposed new specification for standard and extra strength ceramic glazed clay pipe be identical with Specifications C 13 and C 200, respectively. The inclusion of a certification clause in all of the specifications under the jurisdiction of the committee was approved, this clause to be modeled after the clause suggested by the Administrative Committee on Standards.

The committee is considering ways and means of underwriting research in the development of methods of testing clay pipe in long lengths and large diameters.

Lime (C-7)

The need for specifications for limestone for use in the various chemical and process industries received considerable attention at the meeting of Committee C-7. A special task group has concluded that, in view of the tremendous changes taking place in industries such as agriculture, steel, and glass, the development of a universal specification at the present time is practically impossible. In fact, there is no apparent need for a specification for limestone. However, these industries are growing and changing, and the need for specifications and test methods may arise at any time. A permanent subcommittee will watch trends and recommend specifications when the need arises.

The use of pozzolans with lime continues to be an active study area in the committee. The first results of a round-robin test program involving two limes, four fly ashes, and two natural pozzolans were reviewed. Changes in the present specification for Fly Ash for Use as a Pozzolanic Material with Lime (C 379) are under consideration, with a new section contemplated on compacted or nonplastic lime-pozzolan mixtures.

A group has been quite actively studying means of refining the method of determining the plasticity of lime (Method C 110). A test series has been completed involving the use of a synthetic kaolin-flint calibration mixture which will provide a means of calibrating the Emley plasticimeter.

Concrete and Concrete Aggregates (C-9)

Epoxy resins, radiation shielding, testing techniques for vibrated concrete, and standards for lightweight concrete were some of the newer subjects discussed by Committee C-9, on Concrete and Concrete Aggregates, held on June 24, during the ASTM Annual Meeting, in Atlantic City. These subjects represent the latest developments in the broad field of concrete.

The growing use of epoxy resins has led to study by an *ad hoc* subcommittee of the need for standards in this field. Formulation of standards for concrete for nuclear radiation shielding is now the responsibility of a working subcommittee under the chairmanship of Milos Polivka, University of California. Assignments were made to a number of task groups to develop various performance requirements. A test program will be conducted to verify a proposed procedure for vibration of concrete testing cylinders. Although standards are available for lightweight aggregates used in concrete, the need has now been expressed for additional standards to evaluate lightweight concrete. A survey will be made to establish the applicability of existing ASTM methods to lightweight concrete.

Revisions of the specifications for pozzolans (C 402) and for fly ash (C 350) will be presented at the next meeting after cooperative test data have been secured. A proposed new method for microscopical determination of air void content and the specific surface and spacing factor of the air void system on hardened concrete was approved for distribution to the committee.

Gypsum (C-11)

The testing of gypsum and gypsum products is now covered in a comprehensive standard (C 26) which includes both chemical analysis and a number of physical tests. Committee C-11 is studying the advisability of separating the standard into two or more separate standards in order to facilitate its use.

The use of gypsum as a retarder in portland cement has been studied at some length, and the first draft of a specification has been prepared. Revisions in the Specification for Annular Ringed Nails for Gypsum Wallboard (C 380) were reviewed as submitted by the American Iron and Steel Institute, with a number of the suggested changes being accepted.

Manufactured Masonry Units (C-15)

The effect of weathering on brick has been related to a weathering index, which is the product of the average annual number of freezing cycle days and the average annual winter rainfall in inches. Definitions of the terms "freezing cycle day" and "winter rainfall" will now be included in an explanatory note in Specification C 216.

Shrinkage of concrete masonry units has been the subject of a series of round-robin tests. Their purpose was to investigate the agreement obtained with the new Method of Test for Drying Shrinkage of Concrete Block (C 426). Results indicate that the shrinkage of concrete masonry varies considerably with the gradation of the aggregate.

Water vapor transpiration through water-retardant materials is being studied in a series of tests which are expected to lead to the development of an ASTM method of test. Effectiveness of transparent water-retardant materials is being studied in a test program using commercially available transparent water retardents and using various substrate materials, such as mortar, cinder block, and sandstone.

Revisions of the Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units (C 126) were reviewed and approved. These concern requirements for imperviousness, permissible variations in face dimensions, and permissible distortion.

Asbestos-Cement Products (C-17)

A highlight of the meeting of Committee C-17 was a very interesting account of the meeting of the ISO Technical Committee 77 on Asbestos-Cement Products held in Lisbon, Portugal. Committee C-17 has now been officially designated as the American group which will participate in the activities of the ISO Committee. A representative of the Johns-Manville Corp. attended the meeting as the American delegate. It was stressed in the report that the European representatives are very much in earnest in developing international standards and that it was important that the American industry remain active in this work.

The current Specifications for Flat Asbestos-Cement Sheets (C 220), Asbestos-Cement Roofing Shingles (C 222), and Asbestos-Cement Siding Shingles and Clapboards (C 223) will be revised to change the requirements for deflection and water absorption. An additional change in the Specification C 220 will provide for longer and thicker sheets. Consideration will be given to an acid solubility test to replace the present alkalinity test in the two speci-

Technical Committees

fications for asbestos-cement pipe (C 296) and (C 428).

Road and Paving Materials (D-4)

Committee D-4 has announced plans for preparing a manual on testing procedures as applied to design of bituminous paving mixtures. Another new project will be the development of a standard method of test involving the triaxial compression apparatus. Also reported was the completion of four methods of extraction and recovery of constituents for bituminous mixtures. These proposed methods will be distributed to the committee.

Test methods to evaluate bituminous emulsions are being developed through a number of task groups. These methods include a test for stone-coating, water resistance, an inverse demulsibility test, and improvement of viscosity procedure. Task groups are developing a stripping test applicable to asphalt emulsions, the possible use of a flame photometry method, the correlation of stripping tests with road performance, and a study of additive material. A new specification for hot-mix, hot-laid tar mixtures is now in draft form for review.

Bituminous Materials for Roofing, Waterproofing, and Related Building or Industrial Uses (D-8)

A specification for woven glass fabric for use in waterproofing has been accepted by the Society. This specification covers bituminized glass fabric, composed of woven glass cloth treated with either asphalt or coal-tar pitch for use in the membrane system of waterproofing. A new subcommittee on industrial pitches has been formed under the chairmanship of C. U. Pittman, Koppers Co.

Soils for Engineering Purposes (D-18)

The latest in the series of symposia dealing with soil mechanics and the engineering aspects of soils will be a Symposium on Nuclear Devices for Measuring Soil Moisture and Density. The purpose of the symposium is to assemble all available information on the types of nuclear equipment available for moisture and density measurements. It is hoped that several equipment manufacturers will describe their equipment, and that a large number of persons who have used this equipment will tell of their experiences and evaluate the accuracy and usefulness of these devices.

Present plans are to conduct the symposium session as a forum in which all of the papers will be discussed. It is hoped to have all of the papers preprinted.

Committee D-18 is still looking for papers for this symposium. Those who feel that they can make a contribution should get in touch with ASTM Headquarters or Mr. H. F. Clemmer, Engineer of Materials and Standards, District of Columbia District Building, Washington 4, D. C.

Committee D-18 will participate in the preparation of a Manual on Physical and Chemical Analysis of Soils to be published under the auspices of the Soil Science Society of America. Another coordinated activity will be the recognition of the Subcommittee on Nomenclature and Definitions as a joint committee with the American Society of Civil Engineers.

The measurement of permeability of granular soils is described in a proposed method which has been drafted and will now be circulated for subcommittee letter ballot. Further revisions in the sampling methods now published are being considered.

Chemicals, Chemical Products, Water

Paint, Varnish, Lacquer, and Related Products (D-1)

The Subcommittee on Varnish is endeavoring to obtain a master set of glass color standards to be used in certifying individual sets of color standards by spectrophotometric comparisons. A round-robin test program using five types of resins has been planned to determine the applicability of ASTM methods to the testing of the new urethane coatings. Work is being undertaken on the development of a method of test for specific gravity of varnishes.

A long-range project is being undertaken by the Subcommittee on Optical Properties to prepare a recommended practice for color difference evaluation which will include a discussion of color scales and their interrelation. A preliminary round-robin study of the yellowness of a series of white porcelain panels has given very promising results and has helped to define the problem of how one rates yellowness. A more extended round robin will be undertaken in order to obtain answers to the following questions concerning instrumentation: (1) Which measure of yellowness gives the best correlation with visual ratings? (2) How well do different operators and laboratories agree in making yellowness measurements? The task group on Color

Recommend New Committee on Skid Resistance

The skid resistance of pavements, an important factor in highway accidents, has occupied the attention of highway departments and pavement designers since the advent of automobile travel. Testing and research men throughout the country have been endeavoring to establish means of evaluating the skid resistance of pavement surfaces. At the first International Skid Prevention Conference held at the University of Virginia, Charlottesville, Va., September, 1958, there was considerable disappointment shown at the inability to obtain consistent data from a number of state highway departments using testing devices individually designed by these departments. As a result of the conference, it was recommended that ASTM and AASHO assume the responsibility for standardizing a field testing machine, and further, that the recommendations of the conference as to the general nature of the testing machine be considered in their deliberations.

During the recent ASTM Annual Meeting, a conference was held of representatives of three ASTM technical committees: C-9 on Concrete and Concrete Aggregates, D-4 on Road and Paving Materials, and D-11 on Rubber and Rubber-like Materials. After discussion of some of the theories and mechanics involved in the problem, a consensus was reached that ASTM is the logical organization to develop and promulgate national standards for use in evaluating pavement surfaces. It will be recommended to the ASTM Board of Directors that a new technical committee be organized on skid resistance. The scope of this committee remains yet to be developed.

An interesting development in the discussion was the suggestion that no attempt be made to standardize the various testing devices now used throughout the country but rather that a set of standard surface roughnesses be established for use in correlating results from the different testing devices.

There is need for a coordinated program which should include the Highway Research Board, the American Association of State Highway Officials, the Bureau of Public Roads, and the National Bureau of Standards. This matter will be presented to the ASTM Board of Directors at its September meeting.

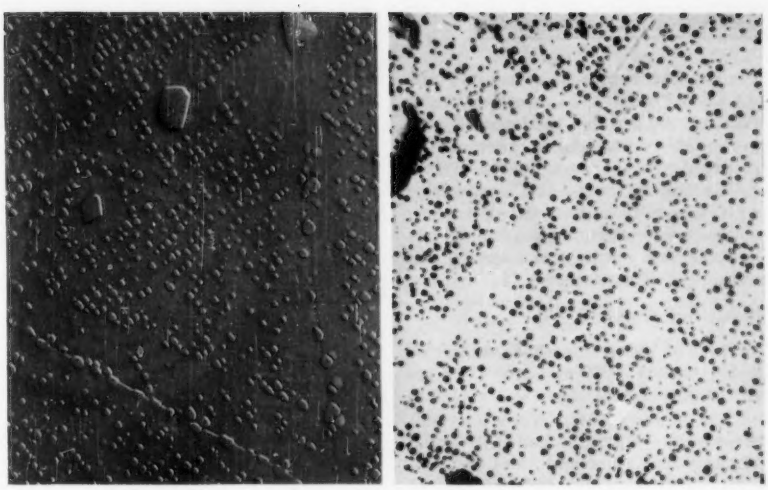
Matching Practices and Light Sources reviewed the results of a survey of the visual evaluation of color differences of seven yellow specimens made by 35 operators.

The Subcommittee on Resins reported results of a statistical analysis of a round-robin study on cold- and hot-cut resin solutions of lower viscosity by the Tentative Method of Test for Viscosity of Transparent Liquids by Bubble Time Method (D 1545). This study has resulted in changes in the procedure regarding details for making the resin cuts and adjusting the viscometer to a particular position. Also the procedure for filling the viscosity tubes will be revised to insure obtaining bubbles of uniform size and pressure. Action was taken to submit as tentative a new colorimetric method for measuring urea in ureaformaldehyde and mixed urea-melamine-formaldehyde resins. Study of the data obtained in a round-robin test program indicated that the precision was equal to that of the Tentative Method of Test for Melamine Content of Nitrogen Resins (D 1597).

A new method of test for efflorescence of interior latex paints has been completed and was presented for committee letter ballot. Proposed definitions of paint film failures characteristic of latex paints have been prepared. Consideration is being given to the development of a method for testing the adhesion of latex paint to chalky surfaces.

The new Subcommittee on Statistical Applications is giving consideration to design of cooperative laboratory tests. It is considering the types of experimental designs that can be utilized by the working groups of Committee D-1 in establishing the sensitivity and precision of methods of test. The group recognizes the fact that in some instances only limited data can be obtained in some round-robin tests and that some laboratories do not have the facilities for including all the desirable variables, such as different instruments, different operators, time, etc. Therefore, attempts are being made, in cooperation with Committee E-11 on Quality Control, to develop experimental designs that can be used under varying circumstances. Each subcommittee will be solicited for test data from completed cooperative tests which will be analyzed to assist in formulating a plan for drafting experimental designs.

The task group on Presentation of Test Data is working on the problem of preparing recommendations for presenting round-robin test data in a manner that is meaningful and easily digested. As a first step, data from a



Aging Precipitate in Inconel-X as Revealed by Electron Microscope Techniques

(a) Negative parlodion replica shadowed with germanium. Etchant: double (1) Glyceregia (2) 1 per cent H_2SO_4 electrolytic.

(b) Extraction replica. Etchant: 5 per cent H_2SO_4 electrolytic-replica subsequently dry stripped.

The electron micrographs clearly resolve the age-hardening phase Ni_3 (Al, Ti) in Inconel-X after aging. The negative replica allows measurement of the size of these particles and the extraction replica allows both measurement and structural identification of this phase. Optimum stress rupture properties are obtained by having the proper size and distribution of these particles. Third Prize, Electron Micrographs, Metals; Eleventh ASTM Photographic Exhibit; by J. R. Mihalisin and R. P. Morenski, The International Nickel Co., Inc., Bayonne, N. J.

National Paint, Varnish and Lacquer Assn. cooperative laboratory testing program is being analyzed to illustrate methods of data presentation.

The task group on Presentation of Statement of Precision of Test Methods has drafted recommended procedures for (1) defining statistical terms involved in precision, (2) outlining various types of precision, and (3) calculating precision.

Consideration is being given to a proposed method for measuring the thixotropic properties of paint. It was agreed that the following three characteristics would probably be required to describe the thixotropic material: (1) a viscosity range or level, (2) the area or some measure of the hysteresis loop, and (3) the degree of recovery of structure after a given length of time. A knowledge of the relation of these properties to performance properties would also be desirable.

The Subcommittee on Lacquers is developing a test for print resistance of wood lacquers which will include procedures at elevated temperatures suggested by furniture manufacturers. The temperatures under consideration are 77, 120, and 140 F. A round-robin evaluation of the proposed method is being planned. An accelerated test for the evaluation of settling and resuspension properties of lacquers is under study by three cooperating laboratories. An accelerated light stability test for clear and pigmented lacquers is under development. An accelerated freeze-shake stability test for lacquers is under study by three cooperators. Additional tests are planned to investigate the following variables: (1) time of aging before freezing, (2) rate of temperature rise, and (3) speed and time of agitation.

The Subcommittee on Painting of Metals has completed recommendations for the preparation of aluminized steel surfaces for painting. Also under development are recommendations for preparation of galvanized iron surfaces for painting.

Aromatic Hydrocarbons (D-16)

The new Subcommittee on Phthalic Anhydride has outlined an interlaboratory test program to study methods for determining solidification point, color of melt, and heat color.

Progress was reported on methods and specifications for naphthalene, pyridine, quinoline, tar acids, phenol assay, and water solubility of refined phenol.

The new subcommittee formed to act as the American Group of ISO/TC 78 on Aromatic Hydrocarbons met to discuss a *modus operandi* for handling ISO work. Present work of ISO/TC 78 covers standards for benzene, toluene, xylene, and solvent and heavy naphthas.

Naval Stores (D-17)

Eight collaborating laboratories reported on three methods of determining

the fatty acids content of tall oil rosin. Additional collaborative work and some fundamental studies to determine the low order of agreement of this work was proposed.

The committee is also cooperating with Committee D-1 in developing methods for determining rosin content in protective coatings and methods of testing tall oil for fatty acids.

Industrial Water (D-19)

Three of the new methods submitted to the Society by Committee D-19 are particularly applicable to water in nuclear power plants. These methods cover the determination of small amounts of copper and silica in high-purity water and the measurement of gamma radioactivity of industrial water and industrial waste water. Work was begun on a related activity, the preparation of specifications for "heavy water."

Particular emphasis was placed on the identification and analysis of water-formed deposits. The committee sponsored a comprehensive symposium on this subject. To promote committee work in this field, a new subcommittee on water-formed deposits was established.

Plans were announced for an extensive symposium on technical developments in the handling and utilization of water and industrial waste water, to be presented at the Third Pacific Area National Meeting of the Society in October, 1959 in San Francisco.

Casein and Similar Protein Materials (D-25)

Ten collaborating laboratories reported on seven proposed methods of testing casein and soy protein. The variability of the data showed the need for revisions, which were discussed at the meeting. Revised methods for sieve analysis, dirt content, insolubles, minimum alkali requirement, odor, viscosity, and foaming will be prepared.

Methods presented for committee action were: ash, free acidity, fat content, and fixed ash of casein and soy protein.

Organic and Fibrous Materials

Coal and Coke (D-5)

A method of test for determining the relative plastic properties of coal by the Gieseler plastometer is being submitted to Committee D-5 for approval. Two other methods in the draft stage are for: measuring the change in pressure of the coal mass during carbonization by the movable wall oven, and measuring the change in volume of coal during coking by the sole-heated test oven.

Experimental work on the test procedures for determining sulfur in coal ash, volatile matter by the modified method, equilibrium moisture, and fusibility of coal ash has been completed. Drafts of these methods as well as the test procedure for mineral carbonates are completed.

The new methods for preparing coal samples for analysis and methods for mechanical sampling of coal are virtually complete. The latest drafts of these methods will be submitted to the committee following subcommittee ballot this summer.

Paper and Paper Products (D-6)

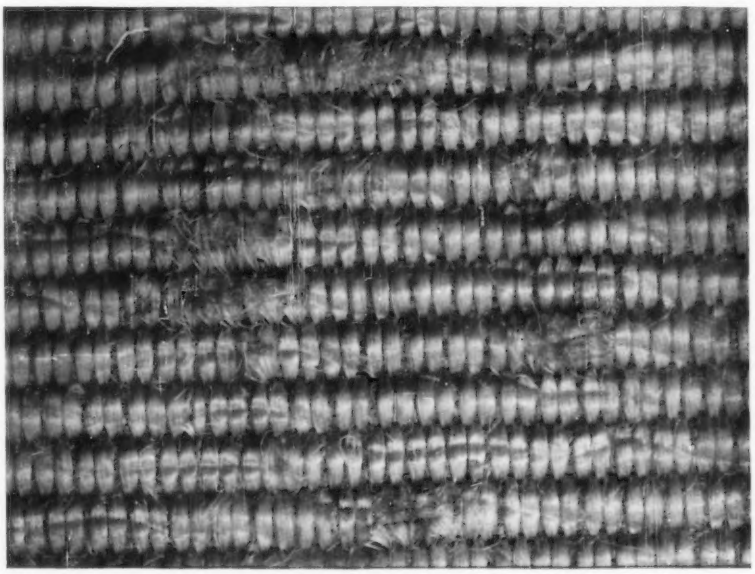
Definitions of particular interest to the paper industry are now being collected for consideration as standard definitions by Committee D-6. Included will be the definitions that were published in *Paper and Paperboard, Characteristics, Nomenclature, and Significance of Tests*, STP 60A (1951).

A task group was set up to cover special methods for testing tissue papers. Progress was reported on sampling for testing and bulk acceptance, basis weight, and tensile breaking strength of paper. New and better apparatus applicable to the Method of Test for Reducible Sulfur in Paper (D 984) will be investigated.

Plastics (D-20)

During 1958, nearly a billion pounds of polyethylene plastics were sold in such forms as unbreakable toys, containers, pipe, wire insulation, and packaging material. Predictions are that this amount will more than double in the next seven years. Polyethylene is one member of the growing family of high polymers known as polyolefins. Because of recent developments in polyolefin-type plastics, which were discussed at some length by Herman Mark of Brooklyn Polytechnic Institute in his 1959 Marburg Lecture, Committee D-20 has established a new subcommittee to develop specifications for these materials. Committee D-20 has long been concerned with polyethylene, and Specification D 1248 is the basis for the present industrial types and grades of this material. In giving this work subcommittee status (previously a section under the Subcommittee on Thermoplastics) the committee is recognizing the importance of these materials to the national economy.

Flammability. A new tentative method of test for flammability of plastics foam and sheeting (D 1692) has been published by the Society on recommendation of the committee. This new test supplements the several other flammability tests for plastics, which have been available for some time, and provides for the first time a procedure covering cellular plastics. The flammability of plastics as compared with



Damaged Fabric

First Prize, Photomicrographs, Black and White—Fibers; Eleventh ASTM Photographic Exhibit. Daniel R. Condon, United States Testing Co., Inc., Hoboken, N. J.

other materials is a property of interest in plastics used in building construction and other applications.

Plastic Pipe. Standards for rigid PVC pipe and polyethylene pipe have been agreed upon for ballot by the plastics committee. It is expected that they will be available toward the end of the year. The committee approved in its annual report a specification for threading reinforced plastic pipe. Nominal pipe sizes from 1.5 to 20 in. are covered.

Sampling Survey. The Subcommittee on Statistical Methods has completed a survey of sampling procedures in ASTM plastics specifications. The survey will be used as a basis for unifying and improving sampling procedures in accordance with accepted statistical techniques.

Burns to Head ISO Plastics in Munich. Robert Burns, Materials Advisory Board of the National Research Council, has been elected to serve as chairman of the Munich, Germany, meeting of ISO 61 Plastics to be held the week of October 26, this year. Twelve U. S. delegates will attend the meeting.

On recommendation of the committee, 18 ASTM plastics standards have been approved as American Standards by ASA.

Electrical and Electronic Materials

Electrical Heating, Resistance, and Contact Materials (B-4)

The reliability of electrical and electronic equipment may often depend to a critical degree on the performance of electrical contacts. Contact performance, in turn, is affected by environmental conditions. In order to study the effect of environmental conditions on contact performance, a group on static connectors and connections is planning an extensive series of experiments to be conducted at ASTM corrosion test exposure sites. These activities are being coordinated by E. K. Camp of IBM with the ASTM Advisory Committee on Corrosion, which supervises the test sites.

On high-current contacts, new test data gave consistent results for erosion rates of tough-pitch copper, standard brass, and tungsten at a constant current of about 1500 amp. Other cooperating laboratories will conduct similar tests before the next meeting.

Study on microcontacts indicates that consistent data can be obtained with forces as low as 0.1 g provided special care is used in cleaning the contacts and adjusting the bearings of the tester. These data were consistent for the five participating laboratories.

Current projects on thermostat metals include development of tests for thermal emissivity, thermal conductivity, corrosion, and mechanical torque rate of coils. A bibliography on thermostatic metals is also being assembled.

Electrical Insulation (D-9)

Magnet Wire. The Society's first standard relating to magnet wire, the Tentative Method of Test for Frictional Characteristics of Enameled Magnet Wire for Use in Winding Filled Coils (D–1676) has been approved. The test results indicate the amount of spooling oil present on the wire. This property is important because wire with insufficient lubricity tends to produce oversize, uneven windings, and excessively oiled wire tends to fall into the space at the coil ends rather than to maintain a compact helix. The method is suitable for control, acceptance, and service evaluation.

Cellular Plastics. Another first by Committee D-9 is the new method for measuring dielectric constant and dissipation factor of cellular plastics. Cellular plastics always have lower dielectric constants than the solid material from which they are derived. The dielectric properties are important because they determine the capacitance between conductors when the plastics are used for encapsulating electrical circuits or components. In transmission lines such as television lead-in cables, etc., expanded plastics are often used to lower the capacitance per foot of cable and to improve propagation characteristics. Cellular plastics are also used in waveguides, radomes, and dielectric lenses for microwave radio and television transmission. In these applications the dielectric properties of the materials are of great importance.

Noncontacting Electrode. In 1958, the committee established a method (D 1531) for measuring the dielectric properties of polyethylene involving displacement of benzene. In this method the electrodes are not in contact with the specimen. This method has now been written for general use and will be added to Methods D 150, the general method for dielectric properties of insulating materials. Methods involving noncontacting electrodes have been found to offer greater accuracy and speed than the more conventional methods involving the attachment of metallic electrodes to the specimen.

Materials for Electron Tubes and Semiconductor Devices (F-1)

A sometimes annoying characteristic of titanium—the ability to hold dissolved gases in large quantities—has been turned to advantage in the electron tube field by using the metal as a getter. Such gases as nitrogen, oxygen, air, and carbon dioxide are all gettered at temperatures lower than the operating temperature of the tube. This finding was brought out by J. E. Beggs of the General Electric Research Laboratories in Schenectady, in a luncheon talk to Committee F-1 at its meeting in Boston, June 17. Dr. Beggs also described recent developments at the General Electric Co. on thermionic integrated micromodules. According to Dr. Beggs, these very small units, which include tiny heaterless electron tubes, as well as resistors and capacitors, are operated at a high temperature developed by the operating currents for the devices. They require no auxiliary cooling.

Contaminants. The new Subcommittee on Contaminants has established three sections on: airborne particulate matter, surface examination, and processing liquids. Considerable interest was shown in the activities of these new groups in view of the very definite correlation of the degree of cleaning of parts with tube performance that was brought out in the 1958 Symposium on Cleaning of Electronic Device Components and Materials, published by the Society as STP 246.

Thermoelectric Materials. A study group under the aegis of the Subcommittee on Semiconductors will survey the interests of industry in establishing standard test methods for thermoelectric materials currently of considerable interest as a means of direct conversion of heat to electricity, using the Seebeck effect, and for cooling, using the Peltier effect.

These materials have been in the news recently as showing great promise for commercial and military applications. While at present there are no significant commercial applications, there is a great deal of effort toward this end in industry and government. This subcommittee has already developed several standards for germanium and silicon. These materials have properties in general similar to the thermoelectric materials, of which most of the promising ones are intermetallics.

Chemical Analysis

Chemical Analysis of Metals (E-3)

Methods for chemical analysis of zirconium and zirconium-base alloys, accepted for publication by ASTM at its 1959 Annual Meeting, are the first methods to achieve official status among a number of methods for nuclear reactor materials under study by Committee E-3. Good progress on the

development of methods for analysis of columbium was reported.

An extensive program of work is under way on new and revised methods for inclusion in a new edition of the Book of ASTM Methods for Chemical Analysis of Metals to be issued late in 1960. All existing methods are being carefully reviewed and, wherever possible, improved methods are being developed.

Mass Spectrometry (E-14)

Some 80 papers covering all phases of mass spectrometry were presented at the meeting of ASTM Committee E-14 in Los Angeles, Calif., May 17 to 22. In addition to general sessions on instrumentation and applications, symposia were presented on degradation of polymers, on machine computation, and on high-vacuum studies. Committee and subcommittee meetings, plant tours, and a clinic sponsored by the major producers of mass spectrometry apparatus rounded out the program.

Analysis and Testing of Industrial Chemicals (E-15)

Committee E-15, consisting of nearly 100 members and representing over 60 companies, held its first full-scale meeting at the 62nd Annual Meeting of the Society. Many of the participants had their first opportunity to participate in the give-and-take of an ASTM committee meeting. Three main groups of subcommittees were established, with the following chairmen:

General—W. A. Kirklin, Hercules Powder Co., chairman of Committee E-15

1. Editorial and Nomenclature.

2. Standards and Reagents—C. A. Flanders, Fisher Scientific Co.

3. Precision and Accuracy—R. J. Sobatzki, Rohm & Haas Co.

4. Sampling—H. O. Hehner, Monsanto Chemical Co.

Division A on General Methods—E. G. Wiest, du Pont Co., vice-chairman

A-1. Elements—L. Gard, Columbia Southern Chemical Corp.

A-2. Functional Groups—J. Mitchell, Jr., du Pont Co.

A-3. Physical Properties—B. H. Cummings, Shell Chemical Corp.

A-4. Water—P. L. Sutton, Spencer Chemical Co.

Division B on Product Methods—J. T. Woods, American Cyanamid Co., vice-chairman

B-1. Mineral Acids—W. Claven, Pennsalt Chemical Corp.

B-2. Alkalies—C. V. Francis, Wyandotte Chemical Corp.

B-3. Alcohols and Polyalcohols—W. R. Dietz, U. S. Industrial Chemical Co.

Subcommittee 3 on Precision and Accuracy outlined its program, in which it will: prepare a glossary in nonstatistical language; formulate precision statements; develop recommended practices for interlaboratory testing, use of statistics, and planning interlaboratory tests; and provide advice on statistical methods to the other subcommittees, including establishing the amount of statistical data needed in methods developed by the committee. The program of Subcommittee 4 on Sampling will include work in two areas—sampling of liquids in tank cars, drums, etc., and sampling solid materials in small containers.

Subcommittee A-1 on Determination of Elements will concern itself initially with determination of chlorine and sulfur in organic compounds. Subcommittee A-2 on Functional Groups established two task groups: one on determination of hydroxyl groups and the other on determination of unsaturation in organic compounds. Subcommittee A-3 on Physical Properties established two projects: one to start compiling uniform density–temperature tables for industrially pure organic liquid chemicals and the other to review melting-point and freezing-point methods for industrial chemicals. Subcommittee A-4 on Determination of Water will review existing Karl Fischer titration methods to select common features as a basis for establishing a general method or a minimum number of methods necessary for this determination.

In Division B on Product Methods, the three subcommittees will survey the literature for methods relating to sulfuric acid, sodium hydroxide, and alcohols and polyalcohols.

The new Committee E-15 will provide a focal point for development and coordination of general chemical methods which has not previously been available in the Society's organization. It is expected that this committee will, in the long run, be of great service to the chemical industry in the establishment of uniform methods of test and data on industrial chemicals. The secretariat of the committee is being supported by the Manufacturing Chemists' Assn., with R. C. Johnson of the MCA staff serving as secretary.

General Subjects

Methods of Testing (E-1)

Calibration of field type testing equipment used for testing concrete and masonry products is not at present covered by the Methods of Verification of Testing Machines (E 4). The product specifications committees will initiate action within their committees to determine what accuracies are required of this equipment. When this information is available, the Subcommittee on Calibration of Mechanical Testing Machines and Apparatus will consider whether to develop methods for field type equipment.

The need for methods of calibrating testing machines used at the high rates of strain now required by the Recommended Practice for Short-time Elevated Temperature Tension Tests of Materials (E 21) was discussed. This recommended practice now specifies a constant normal strain rate of either 0.005 or 0.05 in. per in. per min up to the yield load, and either 0.05 or 0.10 in. per in. per min from the yield load to fracture. A task group was appointed to study this matter.

A new task group of the Subcommittee on Tension Testing will consider the preparation of methods of tension testing for nonmetallic materials. This group will first survey present ASTM methods to determine whether there is sufficient common interest to justify the establishment of an "E" general method.

The Joint ASTM-SAE Groups on Hardness-Tensile Conversions for Steel recommended changes in the conversion tables which now appear in Methods A 370 and in the SAE Handbook. The conversions are applicable to heat-treated steels with tensile strengths over 200,000 psi. This recommendation will be reported to Committee E-1 and Committee A-1 on Steel.

A new table of corrections to be applied to tests made on cylindrical surfaces of metals in the Rockwell B range of hardness is to be added to Method E 18. A similar table for the Rockwell C hardness range now appears in Method E 18.

There is a need for a general method of test for apparent viscosity by the rotating spindle apparatus such as the Brookfield viscometer. This method is now being used for testing a variety of materials such as varnishes, adhesives, vinyl plastics, cement, paint, and bituminous materials. Representatives from interested technical committees of the Society organized a task group to develop a Brookfield viscosity method.

A systematic study is being undertaken of the newer thermocouple materials. The requirements for thermocouples now appearing in ASTM methods of test are being reviewed and suggestions made to the responsible technical committees to improve the specification requir ments for such ther-

mocouples. Consideration is being given to the preparation of a monograph on the use of thermocouples. Extensive information now available in other publications will first be reviewed.

Appearance (E-12)

A major research project has been undertaken by Committee E-12 to develop standards for aluminum finishes based on present methods for evaluating several aspects of appearance. This project is being studied by a task group in cooperation with representatives from Committee B-7 on Light Metals and Alloys.

Progress is being made on the proposed Manual on Appearance Properties of Materials. The committee plans to have the individual chapters for this manual published in the BULLETIN as they are completed for the purpose of soliciting comments and suggestions for further improvement.

The cooperative laboratory studies of a test method for determining the color of petroleum and coal-tar resins have now reached the point where a proposed tentative method is being prepared for committee letter ballot.

A proposed Recommended Practice for Goniophotometry of Reflecting Objects and Materials has been completed and is under review. Goniophotometry is a general procedure for evaluating the geometric manner in which materials spacially redistribute light.

Phobos, Deimos "Man"-Made?

WERE THE TWO little moons of Mars manufactured by intelligent creatures and launched into their orbits about the red planet two or three million years ago? These may be the facts, according to Soviet scientist I. S. Shklovskiy, as reported in a translation published by the Office of Technical Services.

Observation of the two satellites, their sizes, and their motions led Mr. Shklovskiy to this startling speculation. Phobos, he says, has an average density of about one-thousandth that of water, and therefore, he supposes, it is but an empty shell.

The article by Mr. Shklovskiy is one of many translations appearing in two periodicals published by OTS, U. S. Department of Commerce. One is *Scientific Information Report*, a semimonthly review of current scientific and technological advances in the Soviet Union, Eastern Europe, and Communist China prepared from continuing literature surveys by the Central Intelligence Agency. The other is *Information on Soviet Bloc International Geophysical Cooperation—1959*, a weekly account prepared by U. S. Government agencies.

MATERIAL QUESTIONS

Concrete Reinforcing Bars

Why were the requirements for cold-twisted bars deleted from ASTM Specifications for Billet Steel Bars for Concrete Reinforcement (A 15)? Was it because these bars are no longer manufactured and if this is so, what was the reason?

● The action on cold-twisted bars in Specifications A 15, taken several years ago, was the direct result of the committee's decision to eliminate from consideration any materials no longer considered adequate and available as concrete reinforcement.

As a result of the American Iron and Steel Inst. research program on reinforcement, the new A 305 bar was developed, which has found favor with the American Concrete Inst. and authorities on reinforced concrete both in this country and abroad. Research reports indicate bond and anchorage problems with cold-twisted bars that render them most inefficient. Following a canvass of most major producers of reinforcing it was decided that these bars would no longer be available.

Before 1956, the American Concrete Inst. did not accept the use of cold-twisted bars at working stresses higher than those permitted for ordinary reinforcement; building codes, in defining a deformed bar as one meeting ASTM Specification A 305, would not allow a higher bond stress on cold-twisted bars than on plain bars.

In the 1956 revision to the ACI "Building Code Requirements for Reinforced Concrete" (ACI 318-56), two methods of design are permitted: (1) The conventional method based on the theory of elasticity, and (2) the ultimate strength method based on the theory of plasticity and test to destruction. In both methods of design the cold-twisted bar is still considered a "plain" bar with correspondingly low bond stresses allowed. In the conventional method of design, no increase in the working stress in tension would be permitted, above that for intermediate-grade steel. In the ultimate strength method of design, provided that bond stresses are within allowable limits for plain bars, increased yield points due to cold twisting up to 60,000 psi are recognized and may be used.

Galvanized Steel Pipe

I would appreciate knowing if a galvanized steel pipe, specified according to ASTM A120, should be measured for diameter, wall thickness, and weight with or without the zinc coating.

● Galvanized steel pipe specified according to ASTM A 120 is measured for diameter, wall thickness, and weight as it comes off the mill while in the black condition. The zinc coating is then checked in accordance with the specification to see that the proper amount of galvanizing is applied both inside and out.

Mica at High Frequencies

Is mica a good material for use at high frequencies? Do you have specific information on the properties of mica at high frequencies?

● Mica has many properties which recommend its use as electrical insulation in all types of electronic devices. The use you have in mind is one in which it may prove quite satisfactory.

The dielectric constant of muscovite mica containing no or very slight air inclusions is 6 to 7, and the dissipation factor can be as low as 0.0004 or less (Q = 2500 to 10,000). A paper by K. G. Coutlee, "Electrical Quality Classification of Raw Mica by a Rapid, Direct-Reading Test Method," *Proceedings*, Am. Soc. Testing Mats., Vol. 46 (1946) gives dielectric constant and Q values in Table I for a wide variety of visual qualities of mica.

If you wish to look further, we suggest that you obtain copies of ASTM Specifications for Natural Block Mica and Mica Films Suitable for Use in Fixed Mica-Dielectric Capacitors (D 748), Method of Test for Power Factor and Dielectric Constant of Natural Mica (D 1082), and Specification for Natural Muscovite Mica Based on Visual Quality (D 351).

Corrosion Rate of Steel

We are interested in securing information on the corrosion of uncoated iron and steel plate. Our interest is in the oxidation loss in our plate scrap storage pile when we stockpile scrap for a prolonged period of time. (Somewhere we have read that the oxidation penetration is approximately 0.006 in. per year.)

● Although ASTM has no direct data for such a corrosion rate, the test program of Committee A-5 on Corrosion of Iron and Steel, utilizing sheets at various locations, may be helpful. For example, ASTM *Proceedings*, Vol. 54, p. 111 (1954), shows that an open-hearth, 22-gage (0.0306 in.) steel sheet exposed near the Pennsylvania Railroad yards at Altoona, Pa., needed only 9 years to be rusted to perforation, whereas the same sheets exposed at State College, Pa., are still not perforated after 33 years. Calculations based on the perforated sheets would give a corrosion rate of roughly 0.0034 in. per year.

Cross Index for Specifications

I understand that you have published a materials cross-index reference, listing the ASTM specification and the corresponding SAE, AISI, and AMS specifications. If this index is available, would you kindly let me know how it can be purchased.

● ASTM has not published a cross index listing the ASTM specifications and the corresponding SAE, AISI, and AMS specifications. However, the Federal Government has issued a Cross Index of Chemically Equivalent Specifications and Identification Code (Ferrous and Nonferrous Alloys). This "MIL-Handbook-H 1B" dated May 15, 1958, can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $1.75.

ASTM Bulletin

No. 240 September 1959

Nineteen-Sixteen
Race Street
Philadelphia 3, Pa.

Executive Secretary Painter Still in Hospital

EXECUTIVE SECRETARY R. J. Painter, who has been recovering from a hip operation and had expected by now to be carrying out an active program of physical therapy, had to re-enter Chestnut Hill Hospital on August 21. For some reasons not yet clear, the metal ball, which had been successfully inserted into the hip socket on July 3, became dislocated. The joint was re-aligned and is now being held in place by a plaster cast over the entire leg and lower body.

Mr. Painter's doctors expect that he can renew physical therapy on both legs beginning about October 1. This means that he will not get to the West Coast Meeting, to which he has devoted much effort. Meanwhile, Chestnut Hill Hospital has become a branch ASTM Headquarters, with a considerable volume of telephone and mail traffic between there and 1916 Race St.

The Executive Secretary appreciates very much the greetings and remembrances received from many of his friends and associates in ASTM. They have helped greatly to minimize and make more bearable the trying experiences entailed.

Award of Merit Committee

THE 1960 AWARD of Merit Committee, appointed by the Board of Directors, includes G. D. Patterson, Jr. and H. J. Wolthorn, serving with hold-over members A. A. Jones, chairman, and E. O. Hausman. K. B. Woods will represent the Board of Directors on the committee. In accordance with Rules Governing Award of Merit (p. 768, *1958 ASTM Year Book*), all suggestions for 1960 awards must be in the hands of the Executive Committee not later than **Feb. 1, 1960.**

Whence West Coast Meetings?

EARLY IN 1947, the Northern and Southern California Districts invited ASTM to hold a national meeting of the Society on the West Coast. World War II had produced, among other things, a tremendous increase in the industry of that region, and with this came greatly increased ASTM activity. The idea was adopted, and in October, 1949, the first Pacific Area National Meeting was held in San Francisco. It was something of an experiment—could we develop a worth-while technical program? would a truly "national" meeting result? or would it be primarily local in character?

The highly successful 1949 meeting was national in fact as well as in name. Of the 70 papers presented at the 15 technical sessions, half were by authors from east of the Mississippi. One-fourth of the some 800 registrants were from east of the Mississippi or from abroad. Ten technical committees took advantage of the occasion to hold nearly 60 main and subcommittee meetings.

Seven years later, in September, 1956, the Second Pacific Area National Meeting was held in Los Angeles. The program included 43 technical sessions, setting a record for national meetings to that date. Registration was 1537. There were also seven industry luncheons and more than 100 meetings of technical committees and their subgroups. It was obvious that the West Coast had come into its own; periodic national meetings in the West became a Society policy.

In just a few weeks (October 11), the Third Pacific Area National Meeting will convene in San Francisco. So far, there are about 225 papers scheduled for 53 technical sessions, in addition to numerous other features.

Incidentally, the Fourth Pacific Area Meeting is scheduled for Los Angeles in September, 1962.

Random Thoughts at the Annual Meeting

Thursday, 2:15 p.m. Looking about from a position near the ASTM registration desk, we are startled to find not one solitary member or committee member visible. Anyone not familiar with the operations of an ASTM national meeting would certainly wonder what kind of an organization this is, having a national meeting and no one around.

The answer, of course, is obvious. Right now there are three technical sessions under way, including the Forum on Nuclear Problems. There are dozens of committee meetings, including those of the committees on rubber products, cement, and the Joint Committee on Effect of Temperature, from which we have just come. A tour of the hotel meeting rooms would quickly demonstrate that there are many members present and at work.

We have often wished that we could somehow provide a bird's-eye view of the meetings that are going on. If it were possible to knock down all of the partitions between meeting rooms, one could see at a glance that at times more than 65 meetings are running simultaneously, and sometimes in the weirdest places—in corridors, in the four corners of the big ballroom, just about every feasible place.

These meetings afford much of the research planning and the actions on standards which will be used in the production of every conceivable kind of industrial product.

Perhaps giving a bird's-eye view would not be enough, but if we could take any skeptic into just two or three of these meetings for 15 or 20 minutes, he would soon learn that these are truly *business* meetings—the men come to them to learn and to share their knowledge of engineering materials.

Thursday, 8:30 p.m. Riding up in the elevator to the 13th floor, we chat with a group of men who look somewhat tired, and well they might. They have been in constant attendance at a meeting of the advisory committee of one of our main groups from 3 p.m. straight through; and at 9 o'clock there is another joint meeting which they will attend in order to share their ideas on an important problem with representatives of three other main committees. We do not cite this as an average experience—we surely hope that it is not—for the numerous meetings are a physical and mental strain on the men who participate. We are grateful for the devotion of the committee officers and members. These are the men who are turning out the "products" that make ASTM activities so vital to our nation's commerce.

R.J.P.

Actions on Standards

THE ADMINISTRATIVE COMMITTEE ON STANDARDS is empowered to pass on proposed new tentatives and revisions of existing tentatives, and tentative revisions of standards offered between Annual Meetings of the Society. On the dates indicated the Standards Committee took the following actions. Anyone interested in securing copies of the standards should write to Headquarters regarding their availability.

WOOD

Tentative Specifications for Chromated Zinc Arsenate (D 1626 – 59 T) (Accepted July 13, 1959).

Tentative Methods for Chemical Analysis of Chromated Zinc Arsenate (D 1629 – 59 T) (Accepted July 13, 1959).

New Tentatives.—Specifications are provided with methods of chemical analysis covering chromated zinc arsenate, in solid form or in solution, for use in the preservative treatment of wood.

RUBBER

Tentative Specifications and Methods of Test for Closed Cell Poly(Vinyl Chloride) Sponge or Copolymers Thereof (D 1667 – 59 T) (Accepted July 14, 1959).

New Tentative.—These specifications and methods of testing apply to closed cell or noninterconnecting cellular products, the elastomer content of which are predominantly poly(vinyl chloride) or copolymers thereof.

PLASTICS

Tentative Methods for Chemical Analysis of Urethane Foam Raw Materials (D 1638 – 59 T).

New Tentative.—These methods cover procedures for the testing of raw materials in preparing urethane foams. The raw materials cover diisocyanate and polyols including both polyesters and polyethers. Urethane foams are cellular products made by the interaction of polyhydroxy compounds, water, and an organic polyisocyanate.

Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing (D 618 – 58) (Accepted July 13, 1959).

Tentative Revision.—There are provided more specific and more realistic tolerances on temperature and relative humidity requirements for conditioning in the standard laboratory atmosphere, and tolerances are provided which are in agreement with the internationally adopted ISO recommendations.

ELECTRICAL INSULATING MATERIALS

Tentative Methods of Testing Polymerizable Embedding Compounds Used for Electrical Insulation (D 1674 – 59 T) (Accepted June 22, 1959).

New Tentative.—There has been an increasing use of polymerizable compounds in encasement and embedment of electrical and electronic components or assemblies. Methods are provided covering the mechanical and thermal properties of these materials. Tests for electrical properties will be available soon.

Tentative Method of Testing Flexible Vinyl Plastic Coated Sleeving Used for Electrical Insulation (D 1678 – 59 T) (Accepted June 22, 1959).

New Tentative.—These methods cover procedures for sampling, conditioning, dimensions, dielectric breakdown, low-temperature flexibility, blocking and bonding, and flammability. The term "flexible vinyl coated sleeving" as used in these methods refers to a flexible tubular product consisting of glass fiber braid coated or impregnated and coated with a film of plasticized poly (vinyl chloride).

Tentative Methods of Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials (D 149 – 55 T) (Accepted June 22, 1959).

Revision.—The purpose of the revision is to improve the statement on significance and to improve the description of the test procedure.

Tentative Methods of Testing Vulcanized Fiber Used for Electrical Insulation (D 619 – 54 T) (Accepted June 22, 1959).

Revision.—A new Section 21 covering arc resistance has been added.

Tentative Method of Test for Dielectric Constant and Dissipation Factor of Polyethylene by Liquid Displacement Procedure (D 1531 – 58 T) (Accepted June 22, 1959).

Revision.—As the result of this revision, testing of polyethylene of different thicknesses is now permitted.

Schedule of ASTM Meetings

This gives the lastest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
October 1	Committee C-21 on Ceramic Whitewares and Related Products	Bedford, Pa. (Bedford Springs Hotel)
Oct. 7–8	Committee C-8 on Refractories	Bedford, Pa. (Bedford Springs Hotel)
Oct. 11–16	**Third Pacific Area National Meeting** Committees now scheduled to meet at West Coast meeting: B-2 Sub IX and task groups, C-1, C-7, C-9, C-13, C-19, D-2, D-9 Sub V, sections of D-14, D-18, D-20 Sub XVIII, E-2, E-9 Sub V, E-10	**San Francisco, Calif. (Sheraton-Palace Hotel)**
Oct. 13–16	Committee D-13 on Textile Materials	New York, N. Y. (Sheraton-McAlpin Hotel)
Oct. 14–16	Committee B-8 on Electrodeposited Metallic Coatings	Philadelphia, Pa. (Sheraton Hotel)
Oct. 14–15	Committee D-10 on Shipping Containers	Lansing, Mich. (Michigan State Univ.)
Oct. 15	Committee C-14 on Glass and Glass Products	Wernersville, Pa. (Galen Hall Hotel)
Oct. 15–16	Committee C-3 on Chemical Resistant Mortars	Glens Falls, N. Y. (Queensbury Hotel)
Oct. 20	Rocky Mountain District	Denver, Colo. (U.S.Air Force Academy)
Oct. 22–23	Committee C-23 on Sorbent Mineral Materials	New York, N. Y. (Statler-Hilton)
Oct. 26–27	Committee B-1 on Wires for Electrical Conductors	Washington, D. C. (Sheraton-Park Hotel)
Oct. 26–31	ISO Committee 45 on Rubber	New York, N. Y. (Henry Hudson Hotel)
Nov. 5–6	Committee D-14 on Adhesives	Cleveland, Ohio (Case Institute)
Nov. 6	Committee E-13 on Absorption Spectroscopy	New York, N. Y. (Hotel New Yorker)
Nov. 8–13	International Rubber Conference	Washington, D. C. (Shoreham and Sheraton-Park Hotels)
Nov. 12	New England District	Boston, Mass.
Nov. 18	Committee E-11 on Quality Control of Materials	Philadelphia, Pa. (Society Headquarters)
Nov. 19	Philadelphia District	Easton, Pa. (Lafayette College)
Nov. 19	Detroit District	Detroit, Mich.

NEW ASTM PUBLICATIONS

Supplements to Book of Standards

EXCELLENT PROGRESS is being made in getting out the 1959 Supplements to the Book of ASTM Standards. Primarily, these provide the users of the Book of Standards with the new and revised standards resulting from the recommendations acted upon at the Annual Meeting, but they will also reflect actions of the Administrative Committee on Standards, provided these can be included without delaying publication. There will be ten Supplements, one for each of the principal parts of the Book, ranging in size from something under 100 pages for Part 3 to over 400 pages for Part 1.

Although no definite sequence can be given at this time for the appearance of the Supplements, those for Parts 8 and 10 will be available shortly, to be followed by Parts 2 and 4. The plan is to have all of them completed by the end of the year.

Symposium on Testing Window Assemblies

THE GREATLY expanded use of glass in modern architectural and engineering design, as well as the use of many kinds of material in window assemblies has increased the performance requirements of windows. Good performance now includes such factors as structural strength, adequate resistance to rain penetration and to air infiltration, and good thermal properties.

The papers and discussions in this symposium were presented during the 1959 ASTM Committee Week held in Pittsburgh, Pa., Feb. 4, 1959. An international flavor was given to this program by the inclusion of papers describing test programs on window assemblies conducted in Canada and Norway. In the latter country, very severe weather conditions are experienced with combinations of heavy rains and high winds. The contents include:

Introduction—Ray B. Crepps
Evaluation of Factory-Sealed Double-Glazed Window Units—A. G. Wilson, K. R. Solvason, and E. S. Novak
Discussion
Structural Testing of Large Glass Installations—C. R. Frownfelter
Norwegian Test Methods for Wind and Rain Penetration Through Windows—Sven D. Svendsen and Robert Wigen
Need for Research and Development of Test Methods for Windows—L. M. Dunn

STP 251, 52 pages, hard cover, price $2.25, to members $1.80.

Gillett Memorial Lecture

The Role of Dislocations in Plastic Deformation

IT IS NOW known that metals and other crystalline materials deform plastically through the movement of dislocations. High strengths can be achieved by eliminating dislocations entirely, or by the more common method of blocking their motion. At present the dislocation concept makes it possible to account, semiquantitatively, for the strength of alloys.

In this 1959 Gillett Memorial Lecture, presented by Dr. John C. Fisher, General Electric Co. physicist, the theory of dislocations is reviewed and its place in modern materials technology is described. The structure of dislocations, their influence on mechanical behavior, and their role in determining the strength of metals and alloys are explained. Visualization of the concepts discussed is aided by numerous illustrations.

The crying need today is for more and more high-temperature strength. In Dr. Fisher's opinion, we have gone nearly as far as we can in this direction using present-day empirical methods of alloying and treating metals. He believes, however, that a more fundamental knowledge of material behavior, as represented by the theory of dislocations, holds much promise for the future.

Metallurgists and engineers who are concerned with basic knowledge of crystalline materials will find this description of the dislocation theory both stimulating and useful. Single copies of the lecture, printed as a separate pamphlet, are available to members on request. Additional copies to members, 80 cents. List price, $1.

Coal and Coke

Compilation of Standards, D-5

THE 1959 EDITION of the Compilation of ASTM Standards for Coal and Coke contains 29 standards in their latest form. This edition supersedes the 1957 edition.

The volume contains methods of test, specifications, and definitions for both coal and coke. It is of particular interest to utilities, exporters, and importers of solid fuels, transportation companies, and process industries. It is designed to assist technologists and purchasing officials in quality control, purchasing, and use of coal and coke.

ASTM Standards on Coal and Coke, 144 pages, paper cover, price $3.00, to members $2.40.

Symposium on Particle Size Measurement

THIS SYMPOSIUM contains, in addition to 18 papers, a list of ASTM standards pertaining to particle size measurement. Many aspects of this kind of measurement are discussed, including sieves, mechanical methods of separation, electronic methods of measuring, and photoelectric procedures.

The importance of particle size measurement has increased tremendously over the years. Engineers and scientists concerned with chemicals, paint, petroleum, rubber, metals, soaps, concrete, and powdered insulation, to mention a few, have found that particle size plays an important role in the physical and chemical properties of these materials. Considerations of the chemical reactivity, the ability to emulsify, and the stabilization of quality control have defined a need for accurate, rapid, and economic methods of its determination. This symposium presents current thinking in the field of particle size measurement. The contents include:

Introduction—L. T. Work
The Mechanics of Fine Sieving—K. T. Whitby
Application of Electroformed Precision Micromesh Sieves to the Determination of Particle Size Distribution—H. W. Daeschner, E. E. Seibert, and E. D. Peters
Measurement of Physical Properties of Cracking Catalysts (Subcommittee Work Review of the API Committee on Analytical Research)—L. Mittelman
Methods of Particle Size Analysis—R. P. Loveland
Recent Developments in the Hydrometer Method as Applied to Soils—E. E. Bauer
Sedimentation Procedures for Determining Particle Size Distribution—W. F. Sullivan and A. E. Jacobsen
Centrifuge Sedimentation Size Analysis of Samples of Airborne Dusts Collected in Membrane Filters—K. T. Whitby, A. B. Albren, and J. C. Annis
A Liquid Sedimentation Method for Particle Distributions—L. M. Cartwright and R. Q. Gregg
Determination of Particle Size Distribution by Examining Gravitational and Centrifugal Sedimentation According to the Pipet Method and With Divers—S. Berg
A Photoelectric Sedimentation Method for Particle Size Determination in the Subsieve Range—H. R. Harner and J. R. Musgrave
Light Scattering Instrumentation for Particle Size Distribution Measurements—C. T. O'Konski, M. D. Bitron, and W. I. Higuchi
Turbidimetric Particle Size Distribution Theory: Application to Refractory Metal and Oxide Powders—A. I. Michaels

Electronic Size Analysis of Subsieve Particles by Flowing Through a Small Liquid Resistor—R. H. Berg

The Determination of Particle Size by Absorption Methods—R. J. Fries

A Study of the Blaine Fineness Tester and a Determination of Surface Area from Air Permeability Data—S. S. Ober and K. J. Frederick

A Discussion of the ASTM Recommended Practice for Reporting Particle Size Characteristics of Pigments (D 1366 – 55 T)—J. H. Calbeck

The Stanford Research Institute Particle Bank—R. D. Cadle and W. Thuman

List of ASTM Standards for Particle Size Measurement

STP 234, 308 pages, hard cover, price $6.25, to members $5.00.

1959 Supplement to the Bibliography of Spectrophotometric Methods of Analysis for Inorganic Ions, 1952 to 1958

THIS SUPPLEMENT brings the original bibliography of the same title published in 1952 up to date. In general, the basis of selection has been followed in compiling the supplement. However, references to *The Analyst* and *Analytica Chimica Acta* are included for the first time.

The references are not necessarily limited to the use of photoelectric spectrophotometers; other means of detection are used. A small number of papers deal with ultraviolet measurements, since reagents are being found which make work in this region feasible.

The following kinds of methods are not included: fluorescimetry, flame photometry, nephelometry, turbidimetry, and spectrophotometric titrimetry. Also omitted were the many papers based upon Bobtelsky's heterometric titration method.

The bibliography was prepared by M. G. Mellon and D. D. Bly of the Department of Chemistry, Purdue University. Approximately 500 references are listed.

STP 125-A, 28 pages, hard cover, price $1.75, to members $1.40.

Coated and Uncoated Iron and Steel Sheet and Strip

Compilation of Standards, A-1, A-5

THE COMPILATION OF ASTM Standards Relating to Coated and Uncoated Iron and Steel Sheet and Strip is being issued for the first time. There are 21 standards in the volume including eleven specifications for steel sheet and strip, three specifications for metallic-coated steel sheet, two specifications for wrought iron sheet, and one specification for metallic coating materials. In addition there are four methods of test.

This publication presents in a convenient form the ASTM standards relating to sheet and strip steel materials, both metallic-coated and plain. Engineers, designers, and purchasing agents in the construction industry and manufacturers using sheet and strip steels will find the compilation of use.

ASTM Standards Relating to Coated and Uncoated Iron and Steel Sheet and Strip, 148 pages, paper cover, price $3, to members $2.40.

Manual for Rating Diesel Fuels by the Cetane Method

THIS VOLUME, together with the Manual for Rating Aviation Fuels by Supercharge and Aviation Methods and the revised Manual for Rating Motor Fuels by Motor and Research Methods (to be available in late 1959), will contain all standards in their latest form previously contained in the 1952 Manual of Engine Test Methods for Rating Fuel.

The manual now being issued contains Cetane Method D 613 and seven very extensive appendices. The appendices discuss the apparatus necessary for the tests; reference fuels and blending accessories; operation; maintenance; installation and assembly; building and utility requirements, and instrumentation. Numerous illustrations and tables are included.

Manual for Rating Diesel Fuels by the Cetane Method, 138 pages, hard cover, price $8.50, to members $6.80.

Papers Invited for Pittsburgh Conference

SYMPOSIA ON STATISTICAL control of laboratory operation, gas chromatography, nuclear magnetic resonance, molecular fluorescence spectroscopy, application of infrared spectroscopy to trace analysis, applied nucleonics, and X-ray fluorescence spectroscopy are planned for the Eleventh Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy. Sponsored by the Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh, the conference will be held at the **Penn-Sheraton Hotel, Pittsburgh, Pa., Feb. 29 through March 4, 1960.**

Papers are invited on all phases of analytical chemistry and spectroscopy. Deadline for receipt of abstracts is **Oct. 15.** Further information is available from Mr. James E. Patterson, Jones & Laughlin Steel Corp., Graham Research Laboratory, Pittsburgh 30, Pa.

Papers to Appear in Future Issues of the ASTM Bulletin

An In-Place Strength Test for Low Density Concrete—I. A. Benjamin and G. D. Ratliff, Granco Steel Products Co.

Preparation of Compression Molded Polyethylene Test Specimens—A. M. Birks and A. Rudin, Canadian Industries, Ltd.

Continuous Powder Feed Explosivity Test Apparatus—W. D. Box, Union Carbide Nuclear Co.

The Use of Ultrasonics in the Testing of Irradiated Fuel Elements—J. M. Fouts, Hanford Atomic Products Operation, General Electric Co.

Measurement of the Crystallinity and Void Content of Articles Fabricated from "Teflon" TFE-Fluorocarbon Resins—N. G. McGrum, E. I. du Pont de Nemours & Co., Inc.

Segregation in Aluminum–13 per cent Uranium Castings—D. Peckner, Westinghouse Electric Corp.

Design Studies of Capsules for High-Temperature Irradiations—J. H. Stang, W. H. Goldthwaite, and B. W. Dunnington, Battelle Memorial Institute.

New Joint Sealer Testing Machine Developed—R. J. Schutz and A. Van Hauter, Sika Chemical Corp.

High Stress, Low Cycle Fatigue Properties of Notched Alloy Steel Specimens—S. Yukawa and J. G. McMullin, General Electric Co.

A Comparison of the Cenco-Fitch and Guarded Hot Plate Methods by Measuring Thermal Insulation—P. Wing and C. J. Monego, Quartermaster Research and Development Center.

Determining Sample Deflection from Cross-Head Travel in Three Point Flexural Tests—C. D. Doyle and W. V. Olszewski, General Electric Co.

The Effect of Brick Surface Texture Upon the Initial Rate of Absorption—J. T. Hodgins, National Research Council.

District Activities

ROCKY MOUNTAIN

Air Force Academy to Be Site of District Meeting

THE FIRST NATIONAL technical society meeting to be held at the new Air Force Academy in Colorado will be a joint meeting of the Denver Chapter of the Construction Specifications Inst. and the Rocky Mountain District of ASTM, on **October 20.** An all-day program, with eight speakers, is planned.

Arrangements for the meeting have been made by Col. Archie Higdon, professor and head, Department of Mechanics, USAFA; Dr. M. W. Jackson, consulting engineer, representing ASTM; and Marshall Bokar, architect, representing CSI.

Overnight accommodations have been arranged for ASTM members returning from the Third Pacific Area Meeting who wish to stop for the program at the Air Force Academy. Visiting Officers Quarters will be available; reservations should be made with Lt. Col. Lee Standifer, Department of Mechanics, U. S. Air Force Academy, Colorado.

This all-day session will be the third of its kind sponsored by the Rocky Mountain District since its organization in February, 1958. Previous meetings have been held in Albuquerque, N. M., and Salt Lake City, Utah. District Chairman is Howard E. Montgomery, Sandia Corp. The program, not quite complete as of this BULLETIN press date, is as follows:

Morning Session—Chairman, O. F. Pierce, chief chemist, Arizona Portland Cement Co.

ASTM Specifications Applied to Government Contracts—Walter H. Price, chief, Division of Engineering Laboratories, Bureau of Reclamation

Effect of Climate on Building Materials and Construction—Otto Maurer, chief architect, Air Force Academy Construction Agency

Problems in Specification Writing for the Air Force Academy—Edward Merrill, Skidmore, Owings, and Merrill, Architects

Walking Tour of Air Force Academy

Lunch—Buffet in Officers Dining Hall

Afternoon Session—Chairman, Douglas W. Ballard, division supervisor, Products Evaluation and Standards Div., Sandia Corp.

Research and Standards Go Hand in Hand—Member of ASTM Staff

Adhesive Bonding Materials—V. DiBenedetto, Materials Laboratory, Wright Air Development Center

Air Force Photo

New Air Force Academy nestles in the Rockies; snow-capped Pikes Peak towers in the distance

Coming District Meetings

Date	District	Place	Speaker
Oct. 1	St. Louis	St. Louis	A. A. Bates
Oct. 20	Rocky Mountain	Air Force Academy, Colorado Springs, Colo.	All-day session, speakers to be announced
Oct 22	New York	New York City	Allen V. Astin
Nov. 12	New England	Boston	F. L. LaQue
Nov. 18	Southeast (Joint with ASM)	Oak Ridge, Tenn.	F. L. LaQue
Nov. 19	Detroit	Detroit	A. A. Bates
Nov. 19	Philadelphia	Easton	F. L. LaQue

Unique Evaluation Facilities and Techniques for the Space Program—Capt. H. S. Reinert, Wright Air Development Center

Tour of Air Force Academy Including the Trisonic Wind Tunnel in Operation

Dinner—location to be announced, Henry Baume, architect, presiding. CSI President J. Stewart Stein, partner, Sobel & Stein, Architects, will present the charter for the newly formed Denver Chapter of CSI.

The Science of Materials—Dinner address by ASTM President Frank L. LaQue, vice-president and manager, Development and Research Div., The International Nickel Co., Inc.

Symposium on High Voltage Cable Insulation

BECAUSE OF continuing industry expansion and increasing demand for electrical power, the power industry is constantly faced with the problem of distributing higher consumer loads. With recent improvements in electrical insulation materials it is now possible to produce cables for carrying extra high voltages of 250 kv and higher. Insulation for high-voltage cables presents some challenging problems in evaluating properties and predicting service behavior.

These problems will be the basis for a symposium on high voltage cable insulation sponsored jointly by the Insulated Conductor Committee of the American Institute of Electrical Engineers and ASTM Committee D-27 on Electrical Insulating Liquids and Gases. This symposium will be held at 8 p.m. Wednesday, November 18, 1959, at the Governor Clinton Hotel in New York, in conjunction with meetings of Committee D-27 and AIEE. The program is as follows:

Paper for High-Voltage Cable—W. A. Delhar, consulting engineer, Habirshaw Cable and Wire Division, Phelps Dodge Copper Products Corp.

Why and How of Cable Oil Tests—R. B. Blodgett, research director, The Okonite Co.

The Public Utility View of Cable Oils—A. M. Gates, senior engineer, Philadelphia Electric Co., and R. W. Gillettee, senior engineer, Consolidated Edison Co. of New York

While the symposium is primarily for those attending the ASTM and AIEE meetings, attendance is not limited and the public is invited. No registration fee is required.

Additional information may be obtained from V. R. Mulhall, Canadian General Electric Co., Peterborough Engineering Laboratory, Peterborough, Ont., Canada.

ASTM National Meetings—1960-1964

(Members may wish to clip this for their files)

Year	Committee Week	Annual Meeting	Pacific Area National Meeting
1960	February 1–5 The Sherman Chicago, Ill.	June 26–July 1 Chalfonte-Haddon Hall Atlantic City, N. J. (With Exhibit)	
1961	January 29–February 3 Netherland Hilton Hotel Cincinnati, Ohio	June 25–30 Chalfonte-Haddon Hall Atlantic City, N. J.	
1962	February 5–9 The Statler Hilton Dallas, Tex.	June 24–29 Hotel Statler New York, N. Y. (With Exhibit	September 30–October 5 Hotel Statler Los Angeles, Calif.
1963	February 3–8 Queen Elizabeth Hotel Montreal Canada	June 23–28 Chalfonte-Haddon Hall Atlantic City, N. J.	
1964	February 3–7 Sheraton Hotel Philadelphia Pa.	June 21–26 Conrad Hilton Hotel Chicago, Ill. (With Exhibit)	

Photographers Attention!

Plan to Enter the 1960 Photographic Exhibit

THE 12th ASTM Technical Photographic Exhibit will be held in Atlantic City, N. J., June 27 to July 1, 1960, in connection with the 63rd Annual Meeting of the Society and the 14th Apparatus Exhibit.

Materials Processing, Testing, and Research will be the theme of the photo show. Photographs featuring apparatus, instruments, processing techniques, testing, standards, and related items are especially desired. Photographs showing unique or unusual applications of materials are welcome, also those featuring the human element.

Any ASTM member, employee of a member company, or university student interested in engineering materials may submit entries in one or more of the following classes:

1. *General*
   (*a*) black-and-white or monochrome prints
   (*b*) color prints
   (*c*) color transparencies
2. *Photomicrographs*
   (*a*) black-and-white prints
   (*b*) color prints
   (*c*) color transparencies
3. *Electron micrographs*

Entries must be received by May 21, 1960. For details, write to Society Headquarters, Attention: Photographic Exhibit; or use the coupon below.

1960 Photographic Exhibit
American Society for Testing Materials
1916 Race Street
Philadelphia 3, Pa.

Please send me details and application form for the 1960 ASTM Photographic Exhibit

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Why Don't Engineers Learn to Write?*

This is an excerpt from the address, "Education in Engineering: a Perspective," presented by Eric A. Walker, President, The Pennsylvania State University, at the Educational Luncheon, 62nd Annual Meeting of the Society. The full text of Dr. Walker's address will be published, together with the other addresses presented at the Symposium on Education in Materials, in a Special Technical Publication.

THE ABILITY TO COMMUNICATE effectively either heads the list or is close to the top in every survey I have seen of the skills needed by engineers in industry and government. Yet we are still attempting to satisfy it, in so far as I know, in the same way we were attempting to satisfy it in 1900—we require our engineering students to take—and pass—a freshman composition course. This method has not worked in the past, and I see no reason to expect it to work without change in the future.

Why hasn't it worked? After all, this is the same method we use to give our students a solid background in the basic mathematical disciplines, and, with math, it *does* seem to work. At any rate, every employer fully expects the young engineer he hires, if he is a product of a "scientific curriculum," to have developed considerable skill in the use of such basic tools as algebra and calculus—and he is almost never disappointed in this expectation. Is it possible that, although our students *are* capable of learning to use mathematics effectively as a tool for reasoning and communicating, they *are not* capable of learning to use language with equal facility for the same purposes?

This *could* be possible, I suppose, but it is not very probable. I think there is another factor involved that is much more important—I do not think that our faculties have every really taken this demand for improved communications skills very seriously.

Compare, for instance, what happens in these two areas—math and English—after the required courses in them have been completed. After he has completed his basic math course, the student in most engineering disciplines is never allowed to forget what he has learned. He has to take other courses based on the fundamentals he is now assumed to know. He will have to apply these fundamentals in his other courses, and any lack of proficiency in their use will be reflected in the grades he receives. If he demonstrates a lack of ability to use mathematics effectively, his professors will probably give him additional instruction or recommend that he restudy his weak areas on his own time. He is certainly warned, in one way or another, that he must correct his deficiencies if he expects to be graduated. Under these conditions, it really isn't surprising that the bright young men we get in our engineering programs today develop a high degree of facility in the use of basic mathematics.

But how about composition? After he has completed his freshman course in English, the ordinary student is likely to forget everything he is supposed to have learned in the course. Is he ever penalized for this forgetfulness? Of course not. The professors in his advanced courses might occasionally complain about his inability to turn out lucid, coherent papers and reports or to spell correctly, but the grades he receives seldom reflect this inability. If the information presented is accurate, the student gets a good grade—even though it might require superior detective work by the professors to find out that the answers really are there. In fact, the student almost never needs to demonstrate again the proficiency he is supposed to have learned in his freshman comp course until he needs to write a letter applying for a job—and in today's bull market, he can usually avoid even this chore.

In this situation, it's not surprising that engineering students do not learn to write well. Actually, it's more surprising that they learn to write as well as they do, which is just about as well as do the graduates of any other professional discipline. And I am convinced that this situation will not change until the professors—*all* the professors of *all* the courses—establish certain minimum standards for the students' written work and then make it clear to the students that violation of those standards is just as serious as violation of the basic principles of mathematics.

If this were done systematically and carried out energetically, there can be no doubt that engineering students would learn to communicate effectively. In fact, a program of this sort, if carried out conscientiously by the faculties of our engineering colleges, would soon make engineers the most literate of all professional groups in America today.

The difficulty is that this sort of general requirement does not fall neatly into a printed curriculum with course titles and credit hours. Of course, a program of this sort would require that every engineering teacher serve as a part-time teacher of English or, at least, as a critic. But most engineering teachers now serve as part-time teachers of mathematics, and the results of the surveys leave no doubt about the seriousness of the need. Unless we choose to continue to ignore this need, we shall have to return to the old idea that the ability to handle language effectively is, *per se*, a part of the mental equipment of every educated person, including our engineering graduates. If we *insist* that it is, it will be. And we cannot expect much change unless we do insist.

New MCA Study: Fire Safety of Plastics in Buildings

A STUDY TO establish the fire safety of plastics in buildings is under way at Southwest Research Inst. under the sponsorship of the Manufacturing Chemists' Assn. The one-year project, to cost about $19,000, will attempt to compare plastics with traditional building materials, from the standpoint of fire safety and building code regulations. A steering committee composed of S. D. Barradale, N. I. Turner, and C. H. Yuill of SwRI; James Stranch and William Sauber of MCA's Fire Testing Subcommittee; W. E. Manring of MCA's Plastics in Building Committee; and William Demarest, MCA Plastics in Building Director, will periodically review procedures and progress during the study. Technologists and research architects will use actual plans for two proposed buildings, one for multiple-occupancy, such as an office building, and the other for a one-family house.

See You in San Francisco!

. . . at the Third Pacific Area National Meeting, Sheraton-Palace Hotel, October 11-16, 1959

What are the ingredients that promise to make the West Coast meeting a memorable one?

TO YEARS of planning, scores of committee meetings and conferences, hundreds of letters, telephone calls, and telegrams add the thousands of hours of research, technical study, experimentation, analyses of data, writing and rewriting; blend carefully; cook until done with the heat of interest and enthusiasm generated by the General Committee on Arrangements and its subcommittees; serve in the cool refreshing climate of San Francisco. Advance registration received at Headquarters indicates that there will be many fellow ASTM members, committee members, and visitors present to enjoy the results of these labors.

Technical Program

The technical program remains substantially as given in the provisional program distributed the end of May. There are a few changes in some individual papers; several have been withdrawn and new ones added. In the July BULLETIN most of these changes were listed. The over-all outline, which includes the following sessions, remains unchanged.

Session on Paint
Nuclear Problems Forum
Symposia on:
- Adhesion and Adhesives
- Air Pollution Control (2 sessions)
- Applied Radiation and Radioisotope Test Methods (2 sessions)
- Bituminous Waterproofing and Roofing Materials (2 sessions)
- Ceramics in Nuclear Energy (2 sessions)
- Durability and Weathering of Structural Sandwich Constructions (2 sessions)
- Effect of Water-Reducing and Set-Retarding Admixtures on Properties of Concrete (2 sessions)
- Electrical Insulating Materials
- Fatigue of Aircraft Structures (3 sessions)
- Hydraulic Fluids (2 sessions)
- Materials in the Electronics Industry
- Methods for Testing Building Constructions
- Newer Metals (3 sessions)
- Nondestructive Testing in the Missile Industry (2 sessions)
- Post Irradiation Effects in Polymers
- Radiation Effects and Dosimetry (3 sessions)
- Reinforced Plastics (2 sessions)
- Road and Paving Materials (2 sessions)
- Soils for Engineering Purposes (2 sessions)
- Spectroscopy (6 sessions)
- Standards
- Technical Development in the Handling and Utilization of Water and Industrial Waste Water (2 sessions)
- Thermal Ablation (2 sessions)
- Treated Wood for Marine Use
- Wood in Building Construction (2 sessions)

Special Luncheons

Lieut. Gen. Bernard A. Schriever, Commander, Air Research and Development Command, United States Air Force, will be the guest of honor and speaker at the President's Luncheon, Wednesday, October 14. Leading men in their respective industrial fields will speak at five industry luncheons on the following subjects: statistics, petroleum and chemicals, electronics, industrial water, and cement and concrete.

Apparatus Exhibit

Manufacturers, distributors, and suppliers will provide educational exhibits of the latest developments in instruments, apparatus, and laboratory supplies associated with materials research, testing, and quality control. A list of exhibitors and what they plan to display begins on page 22. Several have advertisements in this issue covering apparatus which will be on display.

Entertainment and Plant Visits

Information has been given previously in the advance program, in previous BULLETINS, and in *Circular Letter No. 320*, dated August 28, about ladies' entertainment and plant visits. Accompanying the circular were reservation forms for these events and the special luncheons. Those who have not mailed the reservation forms to Society Headquarters are urged to do so at once.

An Opportunity

For the members in the West, this meeting will provide an outstanding opportunity for those who seldom get to national meetings to meet the national officers and many of the members from the East. The Board of Directors will be meeting on Sunday, October 11, and many are staying throughout the week.

The officers of the General Committee on Arrangements are confident that many of our members and committee members in the Rocky Mountain area and the Pacific Coast states will attend.

Tour of Soil Mechanics Laboratories

The program planned by Committee D-18 on Soils for Engineering Purposes will include a conducted tour of three soil mechanics laboratories in

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Second Forum on Nuclear Problems

As a result of the success of the ASTM Forum on Nuclear Problems held during the 1959 Annual Meeting, a second forum is planned for October 13 in San Francisco.

Sponsored by the ASTM Special Administrative Committee on Nuclear Problems, these forums have a twofold purpose: (1) to acquaint people in the nuclear industry with activities in ASTM technical committees dealing with standardization of materials and test methods, and (2) to bring to light any such activities needed by the nuclear industry in which the ASTM technical committees should engage. The forums are open and informal, consisting of an exchange of ideas between members of the Administrative Committee, members of ASTM committees, and other people engaged in the nuclear industry. The discussions are recorded, cleared through the discussers, and duplicated for distribution.

Transcripts of the first forum are now available, and will be used as the basis for the second forum in San Francisco. Requests for individual copies of the duplicated discussions, furnished free of charge, should be addressed on company letterhead stationery to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

the Bay Area. Present plans include visits to the laboratories of the U. S. Corps of Engineers, South Pacific Division, at Sausalito; the University of California at Berkeley; and Woodward, Clyde, Sherard and Associates, consulting civil engineers of Oakland.

The local committee has made travel arrangements for a party of 25 leaving the Sheraton Palace Hotel at 12:30 p.m. on Thursday, Oct. 15. No charge will be made, but members are asked to register for the tour at the ASTM information desk. The party is not limited, but after the first 25 registrants members will be expected to provide their own transportation. Members wishing further information should contact the local arrangements committee: H. B. Seed or C. L. Monismith, Engineering Materials Laboratory, University of California, Berkeley; R. Lundgren, Woodward, Clyde, Sherard and Associates, Oakland; or E. B. Hall, South Pacific Division Laboratory, U. S. Corps of Engineers, Sausalito.

List of Exhibitors

The second West Coast exhibit of scientific and technical apparatus has been arranged especially for the rapidly growing industries in the area. Instrument and apparatus manufacturers from all parts of the country will have educational and operational displays of the latest apparatus applicable to many fields of interest. The following firms will be among those exhibiting:

American Instrument Co., Inc.

Plastics deflection tester; Filmeter; research chromatograph with Aminco-Karmen RF Glow Detector; Magnegage; Rotary Micro Kjeldahl apparatus for nitrogen determination; high-temperature bench-model oven—1000F; direct-reading hygrometer indicator; Aminco superpressure valves and fittings; quartz and Pyrex absorption cell assortment.

Beckman Instruments, Inc., Scientific and Process Instruments Div.

Megachrom preparative gas chromatograph, a new development for separating complex mixtures into ultrapure fractions as much as 100 times larger than can be done with analytical gas chromatographs. DK-2 recording spectrophotometer with special optics for analyses in the 175 to 200 μ far-ultraviolet region of the spectrum. Other analytical instruments for laboratory such as flame photometers, pH meters, oxygen analyzers.

Branson Instruments, Inc.

Audigage and Vidigage ultrasonic thickness testers, new Sonoray pulse echo flaw detectors, ultrasonic cleaning equipment.

Braun-Knecht-Heimann Co.

Hoke valves, a complete line of valves, regulators, cylinders, flow gages, etc.; Mettler high-speed precision balances; ASTM thermometers; X-ray diffraction apparatus made by Norelco; Precision-Freas laboratory ovens; Precision automatic distillation apparatus indicates and permanently records temperature, time, volume, of any product in the boiling range from 80 to 720 F.

Brewer Engineering Laboratories, Inc.

BEL 18-channel balancing switch, model C, which permits recording and balancing of 18 channels of strain gage information. Remote readings possible, using standard cables and extensions. BEL 6-channel carrier amplifier may be used to amplify 6 channels of strain gage or transducer information for simultaneous electromagnetic oscillograph display. Both sets will be operative.

Buehler Ltd.

Metallographic sample preparation equipment will be on display and in operation. A coarse grinder suitable for metallurgical or spectrographic samples will be shown for the first time, featuring rapid cutting action and rapid abrasive change. Also on exhibit for the first time, a simplified specimen mount press featuring rapid easy actions and low cost. Automet polishing attachment, the ultrasonic cleaner, electro polisher, Handimet grinder.

Central Scientific Co.

Moisture humidity apparatus, entrained air indicator, Chace indicator, vapor phase analyzer, smoke point lamp, Coulometric titrator, Color-matic endpoint detector and volumatic syringe, dew point apparatus, dead weight gage, moisture balance, vacuum oven, interfacial tensiometer, magnetic stirrer with hotplate, and miscellaneous accessories for laboratory use.

Coulter Industrial Sales Co.

The Coulter counter will be demonstrated, a new approach to particle size analysis in the subsieve and low sieve ranges. The new measurement principle applies to all types of materials, such as dusts, pigments, ceramics, foods, chemicals, cement, emulsions, liquid contaminants, metal powders and abrasives. Number and size of particles are measured accurately and rapidly through high-speed electronic sensing of individual particle volumes, without dependence on particle shape, density, or other factors.

Custom Scientific Instruments, Inc.

The Pittsburgh Corning thermal conductivity probe and power pack for K-factor determinations, Setchkin self-ignition apparatus for solids, Dow gas transmission cell, Nopco ball rebound tester, climbing drum peel apparatus for adhesives, Templin calibrator and dial indicator for checking extensometers, dial gages and test indicators, Gregg tension ring for static fatigue testing, heat distortion tester, and CSI-A abrader.

A Daigger & Co. of California

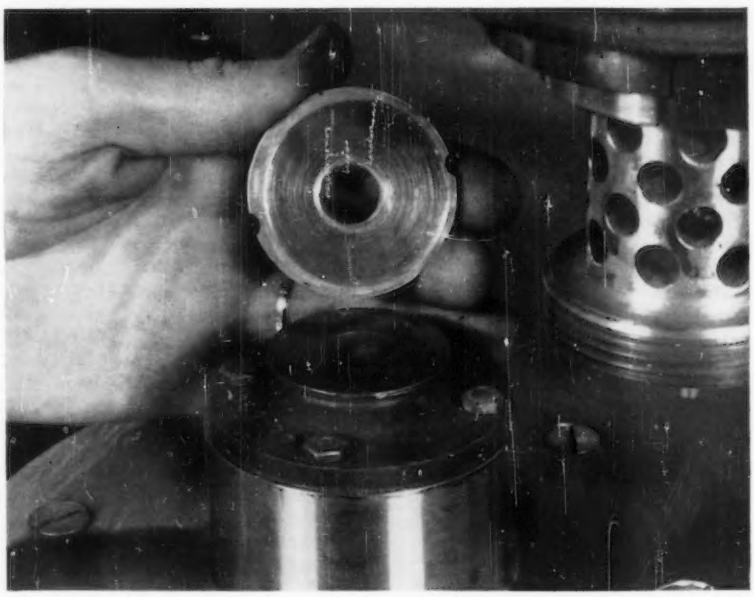
Labline penetrometers, space saver oven, portable hygrometer; Precision Scientific automatic flash point tester, Freas oven, vacuum pump, ASTM colorimeter; Boekel flash testers.

Encyclopaedia Britannica, Inc.

Encyclopaedia Britannica, the world's most complete reference service, and *Britannica Junior*, the children's encyclopaedia. Also on display will be the *Seven Language Dictionary* and the *Britannica Atlas*.

W. C. Dillon & Co., Inc.

Dillon multi-low-range universal tester for rubber, plastic, fabrics, adhesives, and



Metals Rubbed Without Oil

Metals which rub together without damage in spite of heat and lack of oil are tested in this laboratory spindle-and-block fixture. The holes in the spindle let heat escape from the test piece before it can damage the bearings of the test machine. This apparatus was built at Chrysler Corporation's Engineering Division. Honorable Mention, General Black and White or Monochrome Prints, Eleventh ASTM Photographic Exhibit. E. Schroeder and D. N. Collins, Chrysler Corp., Detroit, Mich.

similar materials; model L Universal tester, available in seven different capacities from 0–250 lb to 1–10,000 lb.; model AN dynamometer for materials which, due to size or other limitations, cannot be tested in a conventional laboratory tester; mechanical force gage for measurement of mechanical forces, having 12 different capacities all accurate to within 1 per cent of the full-scale reading.

Gilson Screen Co.

Gilson testing screen and accessories for the test sizing of granular or crushed materials; sample splitter for reduction of large samples in any size range from powder to 4 in. or larger; Porta-Screen, new experimental testing screen model to be offered for public sale in 1960, is lightweight, portable, hand or motor driven, and adaptable to semicontinuous mass separation jobs on a batch basis; experimental edge treatment of testing grade wire cloth sections to eliminate partial openings and prevent loss of fines during mechanical agitation.

Green-Penny Co.

Laboratory furniture and equipment including steel base units, wall cases and floor cases, laboratory table tops, plumbing fixtures, sinks and fume hoods for industrial research serving particularly the pharmaceutical, chemical, and petroleum industries. Furniture for college and university chemistry and physics laboratories and hospital work.

Hallikainen Instruments

Temperature controllers for the laboratory, constant temperature baths, and a null head transmitter for Reid vapor pressure bombs.

Carl Herrmann Associates

Gow-Mac Instrument Co. conductivity cells and gas analyzers; Veeco Vacuum Corp. mass-spectrometer type leak detectors; NRC Equipment Corp. high vacuum equipment; Nuclear Measurements Corp. nuclear instruments; Development Engineering Corp. environmental test equipment; Giannini-Plasmadyne Corp. high-temperature plasma jet equipment.

Howard and Co.

Bruel and Kjaer strain gage apparatus for measuring and indicating static or dynamic strain, including automatic recorder with multi-channel stepping switch for manual or automatic selection; 10-min. color movie on Thermal Dynamics Plasma Flame, a controllable temperature source to 30,000 F, for spray coating, cutting, welding, and research heating for any materials. Kentrall combination hardness tester for standard and superficial Rockwell tests; Kentron microhardness tester; new portable diamond coring machine for sampling concrete and industrial purposes; heavy-duty mechanical soils compactor for ASTM and AASHO standard tests.

Instron Engineering Corp.

Electronically controlled universal testing instruments for testing materials and components in tension, compression, and flexure.

Laboratory Equipment Corp.

LECO induction furnaces, gasometric carbon analyzer, and automatic sulfur titrator in operation. New LECO filtering crucibles for graphitic carbon analyses. Sampling device for preparation of metal samples for oxygen analysis. Acid base method for analysis of sulfur in coal.

Luxo Lamp Corp.

Luxo incandescent and fluorescent type bench and laboratory lights suited to any lighting task, instantly adaptable to the task or job at hand. Luxo lamps are precison balanced with finger-tip control and provide glare-free illumination.

Magnaflux Corp.

Demonstrations of: rapid and accurate measurements of damping factor moduli of materials, determination of degree of stretch in transformation alloys by nondestructive means, electrical conductivity in I.A.C.S. units, means of measuring Curie point of magnetic material while in the furnace, accurate measurement of weak magnetic fields in the presence of earth's field will be featured.

OFFERS OF PAPERS FOR 1960

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1960 and to develop the program for the Annual Meeting to be held in Atlantic City June 26–July 1.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 10, 1960.*

All offers should be accompanied by a summary that makes clear the intended scope of the paper and indicates features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

Nuclear Systems, A Division of the Budd Co.

Gamma radiography equipment for nondestructive testing.

Ozone Research and Equipment Corp.

An operating OREC 0300 automatically controlled ozone test chamber complete with OREC 0300–5 Dynastretch.

The Perkin-Elmer Corp.

Spectroscopic and gas chromatographic instruments and accessories used for the analysis of solid, liquid, and gas samples: model 221 double beam infrared spectrophotometer featuring automatic gain control, program scanning speed, ordinate scale expansion compression, high-speed automatic run back, fast grating-prism interchange; model 4000-A UV-Visible-NIR spectrophotometer; model 137 Infracord® low-cost infrared spectrophotometer; model 154 vapor fractometer including Golay columns and ionization gage detectors; model 194 high-speed printing integrator; model 213 portable hydrocarbon detector for measuring total trace combustibles in laboratory, field, or processing plant.

Rainhart Co.

New and improved equipment for engineering and testing of soils, concrete, asphalt, and other materials. New volumeter for highly accurate in-place density volume determinations; cohesiometer for testing asphalt and other materials; engineering slide rules for easily predicting verticle rises due to soil swell pressures, for expediting designs of flexible pavements, and for rapid calculations of pavement materials quantities; improved mechanical soils compactor; Kelly-Ball for testing fresh concrete; recording beam breaker for flexural strengths of concrete, with companion field checking unit.

Scott Testers, Inc.

Featured will be the model CRE constant-rate-of-extension tester, exhibited for the first time on the West Coast. It employs electronic load measuring and strip chart recording for precision and versatility. Demonstrations of adhesive and tensile strength testing will show how the model CRE can minimize testing costs by reducing setup time, adjustment time, and operator fatigue. Also on display will be samples of clamps and fixtures, and a photographic presentation of equipment offered for rubber, textile, plastic, wire, leather, and other industries.

Syntron Co.

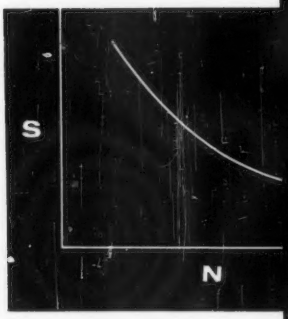
On display will be four of the latest vibratory lapping-polishing machines and the laboratory-type vibrating test sieve shaker. All machines will be operating. The pans of the lapping-polishing machines will be fitted with suitable polishing and abrasive cloths. Sample specimens showing various finishes will also be displayed.

Tatnall Measuring Systems Co., A Subsidiary of the Budd Co.

Photostress and optical strain measuring equipment, Metalfilm strain gages and related instrumentation.

Packaging Specifications Conference at Purdue

EXPERTS IN THE field of packaging specifications will take part in a conference on that subject at **Purdue University, Oct. 5 and 6, 1959.** The problems of transportation companies, the military, package manufacturers, and package users will be considered. Representatives who attend from industries throughout the Middle West will get sound practical help on their own specific problems. Nationally known packaging consultant Charles J. Zusi will coordinate the conference. Further information is available from **Mark E. Ocker, Division of Adult Education, Purdue University, Lafayette, Ind.**



Basic Research in Fatigue of Metals

This summary of the thoughts of the Research Subcommittee of Committee E-9 on Fatigue, partially inspired by criticisms in a recent paper,[1] broadly sketches the boundaries of present knowledge and points to some areas where pressure might be fruitfully applied. The article was prepared by Thomas J. Dolan, chairman of the Research Subcommittee.

SINCE BASIC research is a search for new knowledge without regard to its immediate application, it is difficult to develop a road map for investigators in these uncharted areas. However, it is felt that general guidance can be helpful. Some individuals are strongly opposed to the issuing of "directions" for basic research; they believe that nothing more can result from the efforts of a "task group" than a rehash of present concepts, diluted and brought to their lowest common denominator. Those inclined toward this point of view take the attitude that pure science cannot be planned by some "master board of strategists" directing workers to those fields where gaps exist. When searching for new knowledge there is no way to tell which approach will be most fruitful, and it is highly likely that any startling development will come from work in an unrelated field. For example, if Roentgen had been looking for a way to detect tuberculosis he never would have discovered X-rays.

Some feel that today's emphasis on "group effort" and "togetherness" has no place in basic research. In general, basic research stands or falls with the individual whose opinions are not formed by task groups, but who thinks for himself. Nevertheless, exchange of ideas among alert members of a group can stimulate new ideas in an individual. In fact, with so many alert minds working in any given field, one cannot afford to work in complete isolation; he would soon fall far behind.

A major point of controversy seems to be the definition of what is *basic* or *fundamental*. There is first of all the task of discovering previously unknown things. Let this be called "search." Once a fundamentally new point has been discovered one has to fill in the gap between it and what has been known previously; or one has to apply the new concept or method to a number of different materials. Let us call this activity "research." Evidently "research" in this sense can be carried out according to a prearranged program even by persons who would *not* have much chance of noticing entirely new phenomena if they happened to meet them. On the other hand, in doing "search" every step is determined by the results, stimulation, and opportunities given by the preceding step: the best guarantee of failure is a tendency to stick to a prearranged plan even if the work has disclosed much more profitable paths leading in somewhat different directions.

What is basic to the designer is on an entirely different level of inference and observation from what is basic to a research engineer, which in turn may be different from what is basic to a scientist. Thus, we must recognize different levels of research with a mutual interchange of knowledge and a feedback of new information, techniques, and problems of interest. Within this type of framework there are many levels of investigation that can be suggested as having merit and possible future application to *engineering* analysis of the fatigue problem.

Fatigue failure is merely one manifestation of the behavior of crystalline solids under stress, and only by studying all possible aspects of this behavior can we hope to make real progress in our knowledge of the phenomena. It must be understood by those who undertake studies in this field that even though they follow recommendations of the "board of strategists" and have a well equipped laboratory, they cannot decide to walk into the laboratory on Tuesday afternoon and make an important fundamental discovery. However, by concentrated and intelligent application of new research techniques they should be able to shed additional light upon the instabilities, microreadjustments, surface behavior, or other aspects of the reaction of crystalline solids to repeated stressing. This presupposes, of course, that the investigator is competent, sincere, alert, and that he carefully plans and analyzes every step in his investigational and interpretive procedures.

There are perhaps two distinct areas or levels of observation at which additional work needs to be done to improve our knowledge of the fatigue phenomenon: (1) basic studies are needed to shed additional light upon the occurrences within the space lattice at the atomic level, and (2) studies on the phenomenological or engineering level need to be correlated with these "basic" studies to clarify the relationships between aging, cold work, heat treatment, fatigue strength, and fatigue life. The desired end result, of course, is a set of quantitative relations with which we can predict the influence of manufacturing and fabrication processes. For example, Keith and Gilman's work on lithium fluoride (**1**)[2] promises to clarify the mechanisms of generation and movement of dislocations in the crystal. This type of research usually follows the discovery of a new technique, such as the use of the electron microscope, X-ray observations of changes in lattice structure, etc. Use of new observational tools such as these must certainly improve our knowledge of the mechanisms leading to the initiation and the propagation of a crack under repeating loading. From the engineering viewpoint it appears that the complexity of the fatigue phenomenon can be traced to the fact that progressive fracture is a sequence of at least two phenomena—(1) the initiation and (2) the propagation of cracks—which may be governed by two different sets of criteria. Designers are confronted with the problem of appraising the influence of notches, mean stress, cumulative damage, etc., which may not be the same during crack formation and during crack propagation. Many past investigations have obtained values for fatigue limit or fatigue life for a specific type of specimen under

[1] A. J. Kennedy, "Fatigue Since Wöhler," *Engineering* (London), Vol. 186, Dec. 12, 1958, p. 781.

[2] The boldface numbers in parentheses refer to the list of references appended to this article.

a given condition of stressing and environment. Though thousands of such tests have been made, the results cannot readily be interpreted in terms of general behavior of materials or carried over into the design of actual hardware. This is merely further evidence that we need more complete knowledge of the fundamental behavior that can be applied to many classes of materials for a wide variety of environmental conditions.

The experimenter, whether he is concerned with fundamental or with applied research, must design his experiment to ask the right question in the right way of his test specimens and planned observations. Thus he becomes the responsible quiz master who must attempt to state the problem in a specific manner so that the data will be meaningful. Suggestions for research must not hamper his creativeness or limit his areas of inquiry. The suggestions presented here are intended rather to outline general broad problems of specific concern at the present time and to suggest some of the types of research tools which now seem to offer avenues along which bright young investigators might travel in seeking a better understanding of the many parameters and variables and the manner in which these influence fatigue.

In general, the engineer looks at the problem from the viewpoint of obtaining more concise ideas of the relation between such items as damping and fatigue damage, phenomena occurring above the knee of the *S-N* curve as compared to those below, the relationships between coarse slip and fine slip, influence of atmospheric and chemical corrosion in combination with fatigue, studies of notches, mean stress, effects of overstrain, etc. These worthy areas of investigation require new techniques or unusual methods of approach if we hope to obtain any significant new contributions. It appears that the most promising lines of attack are those recently developed by the metallurgists and physicists involving basic studies of mechanisms on a microscale, such as surface phenomena or the contributions made by instabilities of structure, diffusion of foreign elements in the structure, etc. That is, the best approach to a basic understanding of fatigue consists in making a study of those physical factors which change in a metal as a result of fatigue cycling.

The following items are suggested in a general way as representative of some factors about which information is lacking. The most important of these factors appear to be interaction between interstitial atoms or foreign atoms and dislocations. For steels, the changes in carbon position and form and changes in the stress state are examples of the instabilities and interference effects that occur in

Know Your Committee Officers

To better acquaint Bulletin readers with the men who direct the indispensable work of the ASTM technical committees.

Committee C-1 on Cement

R. R. Litehiser
Chairman
Ohio State Highway
Testing Laboratory
Columbus, Ohio

W. S. Weaver
Vice-Chairman
Canada Cement Co., Ltd.
Montreal, Canada

W. J. McCoy
Secretary
Lehigh Portland
Cement Co.
Allentown, Pa.

J. R. Dise
Technical Assistant
National Bureau
of Standards
Washington, D. C.

Committee D-1 on Paint, Varnish, Lacquer, and Related Products

W. T. Pearce
Chairman
Consultant on
Organic Coatings

E. W. Fasig
Vice-Chairman
The Lowe Brothers Co.
Dayton, Ohio

W. A. Gloger
Secretary
National Lead Co.
Brooklyn, N. Y.

metals. All of these need to be correlated and their mechanisms observed as fatigue cycling proceeds. The over-all criterion will remain the influence of these micro-mechanisms on the "large-scale" or over-all fatigue behavior of a specimen or machine component.

Dislocations

Considerable effort has already been expended in many laboratories in developing etching techniques that will produce pits indicating static dislocation position. This technique opens up the possibility of studying the response of individual dislocations to cyclic stressing. The hypothesis that initiation of a microcrack is the result of stress concentration from the pile-up of dislocations (on the same slip plane) at a barrier may become capable of experimental proof. Probably such studies could be made of simple materials of large grain size, as in lithium fluoride by Gilman and Johnston (**2**). Another hypothesis that might be studied suggests that a crack may form and grow on each loading cycle by being fed by dislocations moving in from the surrounding lattice.

Hirsch and others (**3**) have indicated the possibility of using transmission techniques on thin films of metal in the electron microscope. Such an application permits the observation of dynamic phenomena, but in a way that is more difficult to interpret than with the etch pit technique alone. Future developments of new methods and reproducible techniques of observation and measurement might be possible.

The Berg-Barrett (**4**) method of X-ray diffraction also gives promise of being a tool to determine instantaneous dislocation position. This would then allow the correlation of cyclic stressing and change of position as noted above.

Accumulation of Voids

Another theory indicates the possibility that fatigue crack initiation or propagation may be simply the accumulation of lattice vacancies. Low-temperature data indicate the presence of fatigue even in the absence of thermally induced diffusion through the lattice. The driving force for the movement or accumulation of vacancies is undoubtedly the externally applied stress field. The experimental techniques for examining vacancy accumulations are not so well developed as those for studying dislocation movements. One method that has been used is small-angle scattering of X-rays, as by Guinier (**5**). A second method that has received less attention is cold-neutron irradiation (Dienes (**6**)). The use of these techniques in fatigued material has indicated that growth of clusters of vacancies accompanies increasing cycles of stressing. It is appreciated that vacancy accumulation is probably very intimately tied in with dislocation motion. The intersection of moving dislocations may be the principal cause of the formation of vacancies. Therefore a study of dislocations will yield information on the nucleation of fatigue damage.

Instabilities—Interaction with Interstitial Atoms

Some work by Hempel (**7**) indicates that cyclic stressing will precipitate the carbon that was originally in solid solution into other forms, such as iron carbide. It also seems that such precipitation occurs in the slip lines—the area that eventually becomes the nucleus of the fatigue crack. That such precipitation helps to retard fatigue damage may yet be a point to be established for some of the complex metals and alloys. Precipitation phenomena can be examined and monitored by the use of the high magnification provided by the electron microscope. Determination of internal friction damping is another method that should give some indication of the accumulation of interstitial atoms or precipitates. Much credence is given the belief that there are stress interrelationships between disloca-

This is one of a series of photographs from a collection compiled by Prof. Jasper O. Draffin and displayed in the Arthur N. Talbot Laboratory, University of Illinois.

FRANCIS BACON (1561–1626). Philosopher, statesman, essayist. He perceived the vices of the scholastic method, and was ahead of his contemporaries in striving for a new form of intellectual activity. An advocate of experimentation, he died of pneumonia caught while stuffing a fowl with snow to see whether it would delay putrefaction.

"The human understanding when it has once adopted an opinion . . . draws all things else to support and agree with it. And though there be a greater number and weight of instances to be found on the other side, yet these it either neglects and despises, or else by some distinction sets aside and rejects; in order that by this great and pernicious predetermination the authority of its former conclusions may remain inviolate."

. . . Novum Organum

tions and carbon atmospheres. Thus the altering position of the carbon with stress becomes at least a secondary factor in its possible influence on dislocation phenomena. These effects are not restricted to carbon in iron or to aging effects in body-centered cubic metals, but apply also to nitrogen, oxygen, etc., in a number of metals. In general, they may occur in any alloy for which there is a large change in solubility so that a second phase can be precipitated into the primary phase (as in aluminum alloys).

Changes in Stress State

It is conceivable that structural alterations caused by dislocations, vacancies, or precipitate changes might be reflected in changes in the stress state of the material, particularly on the atomic level. Such changes might conceivably be studied by the microstress method advocated by Warren and Averbach (**8**). This method is based upon the distortion broadening of the X-ray diffraction-line profile. Macro residual stress almost undoubtedly influences fatigue crack propagation and would probably best be studied by the use of measuring techniques based on X-ray diffraction.

Effect of Environment

The fatigue lives of some metals are apparently markedly affected by oxygen in the atmosphere or by changes in relative humidity. Studies of the surface chemistry including the nature and behavior of surface films and of diffusion of foreign atoms into the surface layers might be fruitful. Since the mechanisms of chemical attack and diffusion are sensitive to the effects of time and temperature, these latter parameters should be given careful consideration to determine their relative contribution to the behavior of materials under repeated stressing.

Nonmetallic Materials

Some nonmetallic elements solidify into crystalline forms, but with lattice structures and atomic bonds different from those in metals. The variety of crystalline lattices found in nonmetallic materials is large; it might be helpful to know the fatigue behavior of ionic crystals, ceramic bodies, glassy structures, and of some of the high polymer materials made up of long chain molecules with various degrees of ordered arrangement.

Microplasticity Analyses

Wood (**9**) and Forsyth (**10**) have observed on a micro scale the development of slip band striations and the nucleation of cracks around intrusions and extrusions in metals under cyclic conditions. Though some explanations for these phenomena have been offered in terms of dislocation movements, more experimental and analytical study of the mechanism on the micro scale should be fruitful. These and other phenomena of fatigue may also be studied at a "micro" level by regarding the behavior of an individual crystal in a polycrystalline structure as a phenomenological problem in much the same manner that one would study the strength and deformation of members of "large" size such as a thick-walled tube under internal or external pressure. That is, a sufficiently large number of atoms may be considered as a continuum and the principles of elasticity and plasticity applied to predict the behavior of the crystal as affected by its interaction with its neighbors in the structure. It may be possible to formulate at this level of structure a set of laws for yielding and fracture much in the same manner as has been done for larger-scale polycrystalline structures.

Recapitulation

Many of the foregoing suggestions border on studies closely related to solid state physics; perhaps the results of much of the research suggested would not appreciably change what can be done in the immediate future at the engineering level. There is no assurance that a knowledge of the atomic mechanism of fatigue crack initiation and propagation will make any radical change in what can be done about raising the fatigue strength of a member, such as a turbine blade, for example. Before useful applications can be obtained, the scientists working at the atomic level must attempt to bring their understanding of the structure and its relationship to properties up to the level of the "micro scale," where there could be a common interest with the engineer and metallurgist and a mutual transfer of information that would prove of benefit to both groups.

What is a possible logical outcome of such a program? The hope would be that one of the variables mentioned above or some combination of them would be found to correlate directly with the fatigue process, thus indicating its quantitative importance in the resulting initiation or propagation of the fatigue crack. With such a story documented, it would seem logical that the *next* step would be the "*development* research"—that is, attempts to control this sensitive variable or variables through compositional or processing influences or to put this knowledge into a quantitative form that would enable the designer to predict what would happen when available materials are used in complex systems for which he has not tested a prototype or counterpart.

Acknowledgment

This article summarizes the contributions made by members of the Research Subcommittee, both with regard to the philosophy and the specific suggestions for possible fruitful areas of research. The contributors were too numerous to mention specifically by name but special acknowledgment should be made to Mr. John F. Millan, who assisted materially in the compilation and preparation of the final draft.

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What Materials Will We Need in 1970?

AIA Crystal Ball Shows Materials R and D Needed for Conquest of Space

RESISTANCE TO EROSION by micrometeorites and deterioration in the presence of intense radiation will replace such down-to-earth problems as corrosion and weathering as industry tackles space age requirements in earnest. Other environmental beasts in the space jungle include high vacuum and dissociated and ionized gases. But probably most vexing of all is temperature. In both atmospheric and space flight, the temperature limitations of materials promise to be their Achilles heel.

AIA Report Gives Industry View

Basis for the above statements is the Sixth Annual Forecast of Trends and Requirements prepared by the Aerospace Industries Assn. The report is based on information supplied by AIA member companies and compiled by the Research and Testing Committee, and by the Manufacturing Equipment, Tooling, and Test Committee.

The forecast states that high-temperature performance of materials will be needed in high-speed atmospheric flight, where it is anticipated that skin temperatures may exceed 2000 F by 1970. Re-entry vehicles may experience short-time exposure to temperatures as high as 6000 F or more. It is expected that there will be a leveling off in speeds of atmospheric vehicles at about Mach 4 within the next ten-year period.

Hydraulic and pneumatic systems will be subject to higher pressures, flow rates, and temperatures in the years to come. Aircraft hydraulic systems are expected to operate at temperatures above 800 F and pressures over 6000 psi by 1970. Pneumatic systems are expected to operate at temperatures as high as 2000 F or as low as −300 F at high pressures.

The trend in electronic and guidance systems is toward an increasing use of Doppler-inertial and stellar-inertial systems and away from space-fixed and precessed-gyro systems. These new systems will need reliable gas-lubricated spin bearings and refinements of electrostatic suspension for gyros and accelerometers. These developments are needed by 1965, with subsequent applications of cryogenics to such systems and development of unclear spin gyros by 1970.

As for fuels, the report anticipates that free-radical fuels and nuclear power will be developed in the next ten years which will largely supersede the presently known chemical high-energy fuels as the source of power for high-performance vehicles. Ion rockets and photon engines are farther in the future.

Materials Problems

Of special interest to ASTM are the predictions relating to the materials that now and in the future will find application in aircraft and space vehicles.

Metals and Alloys

The AIA report predicts a trend toward the use of more sheet and less

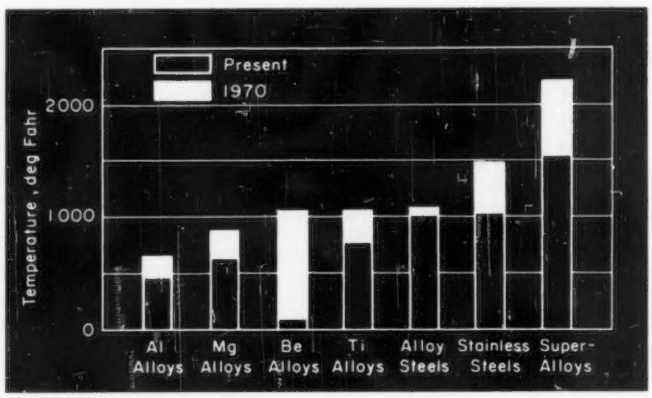

Fig. 1.—Temperature requirements for metals and alloys.

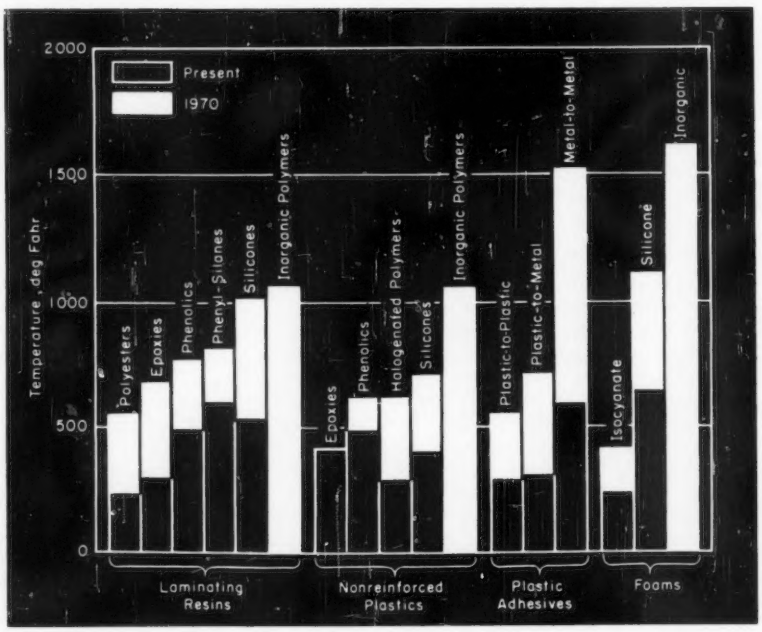

Fig. 2.—Temperature requirements for plastics.

forgings, extrusions, and castings. The sheet will be used in built-up structures so as to take advantage of the superior mechanical properties of future sheet materials. The trend in sandwich construction as well as corrugated panels is toward the welded type from five to ten years hence with an increase during the next five years in adhesive bonding. Anticipated temperature requirements for metals and alloys are shown in Fig. 1. One point not shown is that aluminum alloys may have higher potential thermal limitation through developments in sintered aluminum powder.

Metal Cleaning

Use of conventional chemical cleaning methods including vapor degreasing is likely to continue at a high level but with increasing refinement of cleaning methods. It is expected that etch cleaning, which involves removal of a very thin layer of metal by alkaline or acid etchants, may increase in the next few years.

Plating Material

The trend will be toward increased use of nickel, chromium, and flame sprayed oxides, carbides, etc., with decreasing use of cadmium and zinc plating. Electrodeless plated deposits heat treated for hardness and wear resistance will find increasing use at temperatures up to 2000 F.

Plastics and Elastomers

As with metals, the trend in plastics is toward higher surface temperatures. Figure 2 gives estimated temperature requirements for 200 hr service. Improvement is needed in laminating resins, which are presently the limiting factor in reinforced plastics. The data given in Fig. 2 on nonreinforced plastics do not cover thermoplastics such as polyethylene and vinyls, for obvious reasons. The trend for elastomers indicates that use of natural rubber and neoprene will decrease though the latter will continue to find applications requiring radiation resistance, flame retardance, and moderate temperature resistance. Use of silicones, urethanes, and fluorocarbons is expected to increase because of their superior heat and chemical resistance.

Transparent Materials

For high temperatures it is expected that use of the inorganic glasses and glass ceramics, including silicate glass, synthetic corundum, and quartz, will predominate where temperatures exceed 500 F.

Ceramics and Cermets

Figure 3 shows what is expected for ceramics and cermets including the ceramo-plastics for both time and temperature of service from now until 1970.

Lubricants

The report points out that conventional lubricants will be used over a much greater temperature range than at present by virtue of inert atmospheres or by short-time or continuous-stream application. No single lubricant will be usable over the entire temperature range from near absolute zero to more than 2000 F. At the higher temperatures, it will be necessary to use gases and mists as lubricants.

Textiles and Coated Fabrics

Increased use is anticipated for coated fabrics, both for ordinary lighter-than-air craft and for space vehicles. To be useful in inflated structures these coated fabrics must have low gas-diffusion rates and high strength-to-weight ratios. Present concepts of space vehicles assume that they will use textiles made from high-tenacity polymers of advanced types with gas-tight coatings. The use of glass and other inorganic fibers, as well as metal fibers with suitable coatings is anticipated.

Testing

Because of the very high cost of space experimentation it will be necessary to simulate environments in the laboratory so as to have reasonable assurance that materials will perform as expected. This will require simulation not only of individual environments such as high and low temperature, radiation, and vibration, but combinations of these. The report points out that outer-atmosphere and space flight introduces environments often more difficult to simulate than to protect against. New techniques for generation, measurement, and control of variables will be developed and applied in the next five to ten year period.

A Challenge to ASTM

It is hard to conceive of a more demanding but exciting challenge to materials technology than that offered by the conquest of space. Most of the AIA member companies also actively support ASTM committee work. Since ASTM committees also include many materials producers not associated with AIA, there is a good opportunity for ASTM committees to make significant contributions toward solution of space-materials problems. Indeed, in the normal course of ASTM activity many of these materials problems will be met and solved. But special efforts will be necessary to lead in the international space competition.

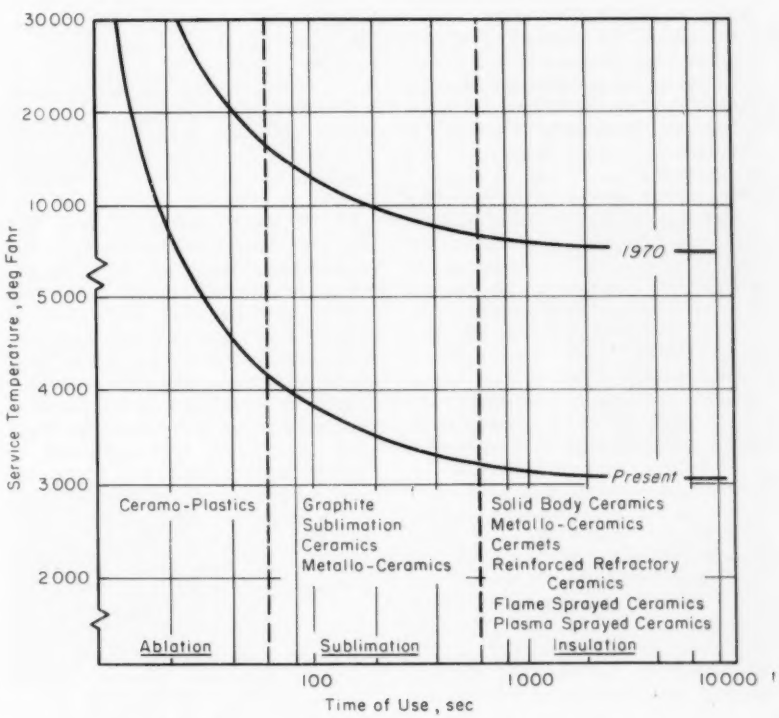

Fig. 3.—Temperature requirements for caramics and cermets.

ACR Notes

Administrative Committee on Research

Further Thoughts on Making Engineering Literature Available

FRANK T. SISCO[1]

In the ACR Notes for December, 1957, I tried to describe the importance of the problem of finding available engineering literature, to indicate the seriousness of the problem, and to emphasize that something should be done soon to solve it. Professional societies, including ASTM, produce annually a tremendous amount of valuable information, which is published and distributed at great expense to professional people in the societies' fields of interest. Unfortunately, however, for these professional people, and for the advance of science and technology, when these societies have published and thus made available this information, they consider that they have met their obligations to the professions they represent, and they usually do not concern themselves further with what happens to this mass of important data.

It seems to me, however, in view of the fact that professional societies do attempt, and at great expense, to keep their memberships, and other interested individuals, apprised of research and development, within their own fields of interest at least, that a society's responsibility should go further than publication and distribution of information; it should offer assurance that this valuable information will remain readily available to everyone as long as the information is valid and useful—which may be for a few months or for many years.

With the exception of a few organizations (for example, American Society for Metals) who are attempting to do something in a limited field to develop a workable system of documentation, professional societies in general reply to anyone who questions their washing their hands of future responsibility for their information that "this is the job of libraries or abstract services." In my 1957 ACR Notes, I tried to show that this is not a valid answer; libraries are usually not equipped to do the job for periodical literature, and abstract services are overworked and underfinanced and, consequently, usually incomplete in their coverage. The result is (to quote from my 1957 ACR Notes): "that in many laboratories it is considered easier and less costly to do a research job than to attempt to find out whether it has been done previously by someone else and reported in the literature." This is a situation that will eventually become intolerable.

Accepting a responsibility for valuable information beyond publication and distribution should be attempted individually and collectively by the professional societies, and I am convinced that if they do not do it themselves, the Government will eventually do it for them. The Soviet government is already attempting to do this in the Institute of Scientific Information of the Academy of Sciences of the USSR. In the United States, there is a step in that direction—on April 28, 1959, the Federal Council on Science and Technology suggested "that the Scientific Information Service of the National Science Foundation make a study of improved means for information exchange in the materials research and engineering field."

The management and the membership of ASTM should note that the categories suggested for improved information exchange in the "materials research and engineering field" are (1) individual materials, (2) types of materials, (3) properties of materials, and (4) end-use of materials. One or more of these categories are of interest to a considerable number of our present-day professional societies, but all of them are of interest to ASTM—in fact these four categories spell out the *raison d'etre* for ASTM.

For some years, the ASTM Administrative Committee on Research has been seeking ways to encourage the Society to do more in materials research. At the Annual Meeting of the Society some 30 research-minded ASTM members met to discuss with the President and other national officers the possible functions and future activities of the newly established Division on Materials Sciences. Personally, I am convinced that individuals and organizations (including the Federal Government) in all technological fields would be eternally grateful if the ACR and the new Division on Materials Sciences would undertake a study that would help to answer one of the most pressing problems facing us today, namely, how can we improve information exchange and how can we keep such information readily available on "individual materials, types of materials, properties of materials, and end-use of materials."

[1] Director, Alloys of Iron Research.

ISO Approves ASTM-IP Petroleum Tables

The International Organization for Standardization has approved American Standard Z11. 83-1956 — Petroleum Measurement Tables — as ISO Recommendation 91.[1] These tables have been a joint standard of the ASTM (ASTM D-1250) and the Institute of Petroleum (British) (IP 200) since 1952. The tables had been approved by the American Standards Assn. upon the recommendation of ASA committee Z11, which functions under ASTM sponsorship.

The United States proposed the tables for consideration as an ISO Recommendation through ISO technical committee 28 on petroleum products. The secretariat for this ISO activity is held by the U. S., with W. T. Gunn, director of the division of refining of the American Petroleum Institute, serving as secretary of the committee.

Bearing the ISO approval, the tables will continue to be published by the Institute of Petroleum in England, and by the ASTM in the United States. Their international recognition is a source of satisfaction to petroleum technologists in this country and in England. As a result of this recognition, the practice of the American and British petroleum industries will become the measurement procedures for international trade purposes.

Measurement Problems in the Instrument and Laboratory Apparatus Fields

By E. L. RUH, J. J. MORAN and R. D. THOMPSON

IT WOULD be interesting and valuable to explore the facets of all difficulties traceable to measurement units as encountered in the laboratory. From such a fund of knowledge one could adequately prepare a statement of the over-all problem and its possible resolution. Because time will not permit such extensive exploration, it will be our endeavor, after a few general remarks, to outline the problems in three specific areas of laboratory measurement: temperature, gravity, and liquid viscosity.

THIS PAPER was presented at the Symposium on National and International Aspects of Systems of Units sponsored by the American Association for the Advancement of Science, Washington, D. C., Dec. 29, 1958. Together with the other papers presented at the symposium it will be published shortly by the AAAS in a symposium volume, *Systems of Units*.

General Discussion

If it had been possible in the past for all instrumentation for laboratory measurements to yield precise information, conveniently, in terms of absolute units that expressed the physical laws involved, it is probable that many of the problems now confronting us would not have arisen. An analysis of the extent to which this has been achieved in various fields would throw much light on our subject. Review of the motives and circumstances that originally fostered the inception of any method of measurement would also be very revealing. Here could we discount the influences of war, of personalities, and of prejudices—individual or national?

In some areas of measurement the metric system is firmly entrenched, in others the English, and in still others arbitrary systems not traceable to any basic system are used. In the field of laboratory glassware, for example, the metric system is quite generally used. Users are accustomed to specifying apparatus in metric units, and manufacturing plants use metric units of length and volume to produce the apparatus. Some few pieces of volumetric glassware such as druggists' graduates are scaled in U. S. customary units, and there is little possibility of complete elimination of such glassware unless it becomes the fashion to supply consumers with metric packages.

The standard temperature for volumetric apparatus in the United States is 20 C, although there has been some agitation for adoption of 25 C, since the latter figure more closely approaches the actual temperature of the average laboratory. There is considerable merit in such a change, but it is improbable that manufacturers of apparatus will adopt it, unless the National Bureau of Standards should advocate the higher temperature.

The chief difficulty with units of measurement in the glassware industry occurs when a fit must be made with another piece of equipment made of other materials such as metal. The metalworking industry is almost completely based on U. S. customary units of length. The conversion of millimeters to inches, and *vice versa*, frequently results in inconveniently complicated numbers. Further, because of the common tendency to use simple numbers in industry, complications arise. For example, if a metal rack is designed to hold glass tubes listed in catalogs as being 25 mm in diameter, 1-in. (25.4-mm) holes may be drilled in the rack. But the usual tolerance on glass tubing of this diameter is ±0.5 mm. Hence, many of the glass tubes will not fit, and the use of standard stock tubes will be prevented. This is not a hypothetical case. It actually happened recently in a large laboratory.

ERNEST L. RUH, Senior Chemist with the Esso Research and Engineering Co., has been responsible for standardization, development, and supply of testing apparatus to laboratories affiliated with the Standard Oil Co. (N. J.) for more than 25 years. Prior to 1959, he participated actively on many ASTM Committees dealing with laboratory equipment and was chairman of the USA Committee for ISO/TC 48-International Standardization Organization for Laboratory Glassware and Related Apparatus.

JAMES J. MORAN has been with the Kimble Glass Co. since 1920. During most of this time he has been concerned with glass laboratory apparatus, including all phases of manufacturing, advertising, and selling. At the present time, Mr. Moran is technical director for the Scientific Sales Division. Mr. Moran has long been active in ASTM work. He is a member of Committee D-2, on Petroleum Products and D-15, on Engine Antifreezes, and the six subcommittees of Committee E-1 that are concerned primarily with laboratory apparatus. He is chairman of Subcommittee 19 on Laboratory Glass Apparatus.

R. D. THOMPSON, is Chief Development Engineer for Commercial and Glass Products of the Taylor Instrument Co., Rochester, N. Y. His work has included research, product engineering, development, and standardization in the fields of thermometry and hydrometry. He is presently chairman of Subcommittees 17 and 18 of Committee E-1. He is a member of Committee E-1 and is also one of the newly elected Directors of the Society.

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

Temperature

In the measurement of temperature the use of a variety of scales is confusing and annoying. In this country the Fahrenheit scale is commonly used in engineering circles and by the layman, whereas in the natural sciences and the other physical sciences the Celsius scale, formerly called Centigrade, has long been employed. To complicate matters further, in specialized fields such as sugar refining and brewing, still a third scale, the Reaumur, is popular.

Now we all recognize that in consideration of any subject it is important that the participants employ a common language. Failure to do so precludes even the start of a discussion. Consider, for example, an engineer thinking almost instinctively of degrees Fahrenheit and a physicist as firmly entrenched in degrees Celsius, discussing a problem in heat flow. Unless there is a constant meeting of the minds as to units, what hope is there for success in solving the problem? While every "Quiz Kid" can glibly spell out the conversion formulas, it must be conceded that intensive use of one scale to the exclusion of the other is a definite barrier to effective communication.

In the thermometer manufacturing industry the problem is magnified. Every manufacturing order must be carefully checked and double-checked to make sure that the desired temperature scale is being incorporated into the product. In so far as possible the manufacturer tries to use the same style of uncalibrated, liquid-filled tube or "blank" thermometer for the construction of either Fahrenheit or Celsius instruments. For obvious economic reasons this is important. This factor, however, is currently a roadblock in the way of international standardization. ISO Technical Committee 48 has for several years endeavored to develop specifications for precision-type thermometers. The draft proposals which have been prepared for Celsius instruments are quite acceptable in those countries where that scale is used exclusively. However, in this country in particular, both Celsius and Fahrenheit thermometers are required. The designs proposed do not provide the interchangeability desired by U. S. manufacturers. Hundreds of words have been written and spoken in an effort to resolve this problem, but at this point the desired compromise seems far away.

[1] "The Baumé Hydrometers," National Academy of Sciences, Vol. III (1881).

[2] United States Standard Hydrometer Scales, *Circular of Bureau of Standards No. 59*, April 5, 1916.

[3] ASTM-IP Petroleum Measurement Tables, American, British and Metric Editions, published jointly by Am. Soc. Testing Mats. and Inst. of Petroleum, 1952–53.

Gravity

The second subject we would consider in some detail is that of "gravity." From the very beginning of commerce in petroleum products there has been the necessity for quick and accurate measurement of material density, or gravity, and temperature. These might seem to be simple fundamental properties, easily measured. Density, or mass per unit volume, which certainly could be expressed in fundamental units, was unpopular in America and was ruled out, apparently because of inconvenience in measuring.

So-called "gravity" of a liquid could be either a direct relationship between its weight per unit volume and the weight of an equal volume of water expressed as specific gravity, or it could be an indirect relationship such as that devised by Antoine Baumé in 1768. Specific gravity, like density, was not popular with early petroleum scientists. Suppliers found specific gravity hydrometers more difficult to make than the Baumé type and oil men found them more difficult to use. Scale readings were made down instead of up and the scale graduations were not spaced equally. The result was fairly general adoption of the Baumé instrument.

Baumé had proposed two scales, one for liquids heavier than water and the other for those that were lighter. While the scales, empirical in nature, were simple to prepare, Baumé's directions were not specific. In their application it is interesting to note that C. F. Chandler, reporting to the National Academy of Sciences in 1881,[1] stated that he had "found 23 different scales, published by as many writers, for liquids heavier than water—no one of which can be said to be correct, or to have been obtained by following Baumè's directions." For liquids lighter than water, Chandler found 11 different scales.

Chandler's report resulted in some clarification so that by about 1904 when the Bureau of Standards contemplated the standardization of hydrometers[2] " . . . diligent inquiry was made of the more important American manufacturers as to the Baumé scales used by them." Without exception they replied that in relating their Baumé to specific gravity reference standards they were using the modulus 145 for liquids heavier than water and 140 for liquids lighter than water. These moduli were adopted by the Bureau of Standards as the American Standard for use in the mathematical relationships between Baumé and specific gravity. Despite this standardization, it was subsequently discovered that most of the hydrometers in use in the American petroleum industry had been erroneously manufactured to a modulus of 141.5 rather than 140. By 1921 this condition had become so firmly entrenched that the only seeming remedy was to recognize the scale in predominant use and rename it. Thus was born the API hydrometer scale.

With this development there were those hopefuls who believed oil measurement problems would diminish upon universal acceptance of API gravity. However, constantly expanding international trade and the exigencies of two world-wide conflicts denied such hope. It became clear that until mankind progresses to the point of world acceptance of what can be shown to be the best system, all systems with merit must be recognized.

It is noteworthy that in 1952, after more than six years of cooperative effort between the ASTM and the Institute of Petroleum in Great Britain there resulted a publication which is most unique in character. It is the well-known collection of Petroleum Measurement Tables, 39 in number, based on the systems of density, specific gravity, and API hydrometry. The approach to complete international understanding is recognized in the following excerpt from the foreword that appears in the American, British, and Metric editions, the latter being published in three languages: "In order that the collection might contain collated tables for use in any country, regardless of units of measure used by custom or statute, a conference was held in Brussels in 1949 at which twelve countries using the metric system of measurement were officially represented. As a result of this active cooperation, the three widely used systems of measurement are represented in the collection, all interrelated, to meet the world-wide need for a uniform and authoritative publication to serve as a basis for standardized calculations of measured quantities of petroleum regardless of point of origin or destination."[3]

As a corollary, ISO Technical Committee 25 on Petroleum Measurements is currently developing an international standard method of test for gravity of petroleum products by hydrometer. In that method it is planned to recognize the density, specific gravity, and API systems of measurement. Simultaneously ISO Technical Committee 48 on Laboratory Glassware and Related Apparatus is developing an international standard specification for density hydrometers which has recently been used in this country as a pattern for redesign of the ASTM specific gravity and API instruments.

Viscosity

To explore all of the problems related to the measurement of viscosity would

be a prodigious undertaking. Even those specific to the testing of petroleum products can only be touched upon. Because the petroleum industry has been rapidly assuming the nature of a chemical industry, it has been adding tremendously to its viscosity measurement problems. Fluids ranging in viscosity from fractions to millions of poises must be measured. In dealing with homogeneous as well as nonhomogeneous fluids exhibiting various kinds of flow, satisfying answers must be found over a broad range of temperatures. Whenever possible, instrumentation is employed to yield values in fundamental viscometric units, but more often the results are expressed in arbitrary terms.

The literature of the petroleum industry provides descriptions of a great number of viscosity systems and measuring devices all serving in one way or another to evaluate resistance of fluids to flow when acted upon by external forces. With such a multiplicity of systems and devices there have arisen a number of problems. The greatest problem stems from this very multiplicity. Difficulties incident to the use of a wide variety of terms for expressing viscosity are perplexing enough but they dwindle before the confusion which results from attempts to relate results obtained at various temperatures in English and metric systems. Another problem common to most of the useful viscosity systems in use for any length of time has been the need and demand for greater precision than that for which the system was devised originally.

Viscosity measurements seem to have suffered unduly from the influence of attitudes conducive to maintaining the *status quo* and from expediencies stemming from war emergencies. During 1917, when ASTM Committee D-2 on Petroleum Products and Lubricants was weighing the relative merits of the Engler and Saybolt viscosity measurement systems, the following account entered the record:[4] "The committee feels, however, that for the sake of uniformity, some action should be taken upon standard temperatures for viscosity. . . . The temperatures in most general use in this country are 70, 100, 130 and 210 F, but numerous other arbitrary temperatures are used to a certain extent, resulting in great confusion. In view of the fact that the tendency, both in the Society and in the country at large, is toward the adoption of the Centigrade scale, it is recommended that the Centigrade temperatures nearest approaching these Fahrenheit temperatures in round numbers, be adopted." It was suggested that 20 C, equivalent to 68 F, rather than 70 F be used; 40 C, equivalent to 104 F, rather than 100 F be used; 55 C, equivalent to 131 F, rather than 130 F be used; and 100 C, equivalent to 212 F, rather than 210 F be used.

A year later the annual report of Committee D-2 stated:[5] "... The committee further recommends that the 'Standard Temperatures for Viscosities' contained in the tentative tests submitted last year be withdrawn. In explanation of this recommendation, the committee believes that while eventually the adoption of these standard temperatures will be desirable, such adoption is not feasible at the present time. . . . Due to war conditions, not only has the use of Fahrenheit temperatures greatly increased in this country, but these temperatures have also been adopted abroad—for instance, by the British government . . . An attempt to change the standard temperatures at the present time would result in confusion in the specifications for oils for the various governments and might tend seriously to delay matters looking toward the successful prosecution of the war. The committee anticipates that at a later date it will again present these temperatures for adoption as standard by the Society." This intention was never fulfilled.

Again in 1919, when the committee was about to favor adoption of the Saybolt viscosity system, one member made the following plea for a more fundamental approach.[6] "It is unfortunate that our Society should put itself on record without at the same time pointing out the limitations of the instrument. The fact that the readings are in seconds and not viscosities, not cgs units, is a more or less minor matter; the fact that they vary with the density of the material is again an objection, but not a major difficulty; but the fact that for some readings the instrument would have one multiplying factor to reduce its readings to absolute viscosity, and throughout a considerable and much more commonly used range a very different and extremely variable multiplying factor constitutes a very serious objection to the Saybolt Viscosimeter as a standard instrument, approved by the Society."

The reasons given for overruling this farsighted approach were: (1) the Saybolt system was in general use, (2) it was used by the War and Navy Departments, (3) it was prescribed in specifications prepared by the Bureau of Standards, and (4) it was prominent in specifications of the U. S. Railroad Administration. That the Saybolt system today, 40 years later, is retiring before measuring means more closely related to fundamental principles is a tribute to those who stood for a more fundamental approach in the past.

Conclusion

Consideration of measurement problems such as those described in the fields of thermometry, hydrometry, and viscometry, along with others, leads to the conclusion that such problems arise from a variety of causes. These include:

1. Failure to base instrumentation on fundamental units or principles.
2. Errors in judgment.
3. Reluctance to deal in another's language.
4. Desire to maintain the *status quo*.
5. Difficulties in instrument manufacture.
6. Lack of convenience in use of existing methods.
7. Complexity of interrelations and conversions.
8. Extension of limits of measurement.
9. Failure to recognize the inadequacy of existing methods.
10. Selfish preservation of proprietary interests.
11. Influence of unusual circumstances —such as war.
12. Yielding to expediency.

We suggest that the following would help to reduce or eliminate many measurement problems:

1. Develop new tests or methods of measurement on fundamental principles.
2. Eliminate inferior methods as rapidly as possible.
3. Avoid repetition of past errors.
4. Make maximum use of existing standardization activities.
5. Work toward ultimate international standardization wherever possible.

In the endeavor to make maximum use of national and international standardization, it would be well to review past experience carefully. Too often standardization has been sought subsequent to the development and practical application of a large number of procedures whose objectives had much in common. A glaring example has been the multiplicity of tests and devices mentioned for measuring viscosity. It is certain that great benefit would accrue in all fields of activity if standardization organizations were to anticipate needs for measurements and reverse the approach taken in the past. Standardization should attend full development of a new activity rather than appear as a resulting effect.

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[4] Report of Committee D-2 on Lubricants, *Proceedings*, Am. Soc. Testing Mats., Vol. 17, Part 1, p. 462 (1917).

[5] Report of Committee D-2 on Lubricants, *Proceedings*, Am. Soc. Testing Mats., Vol. 18, Part 1, p. 321 (1918).

[6] Report of Committee D-2 on Lubricants, *Proceedings*, Am. Soc. Testing Mats., Vol. 19, Part 1, p. 389 (1919).

Cryogenic Engineering of Hydrogen Bubble Chambers

By B. W. BIRMINGHAM, D. B. CHELTON, D. B. MANN, and H. P. HERNANDEZ

Low-temperature material problems encountered during the development of a liquid-hydrogen bubble chamber are discussed. Properties affecting the selection of the bubble chamber material, the glass window, and the thermal radiation shield are examined. Methods of sealing the glass window to the chamber with various gaskets suitable for use at liquid hydrogen temperature (−423 F) are presented. In addition, a method of continuously maintaining the bubble chamber and contents at liquid hydrogen temperature by means of an external refrigerator is described.

A liquid-hydrogen bubble chamber having a volume of about 550 liters has been designed and constructed to operate with the Bevatron, the six-billion electron-volt particle accelerator at the Lawrence Radiation Laboratory (LRL), Berkeley, Calif. Many unusual low-temperature material problems exist and are worth-while reporting. The National Bureau of Standards' Cryogenic Engineering Laboratory has assisted LRL in portions of the design involving the application of special low-temperature knowledge. Where necessary, experiments have been carried out at liquid-hydrogen temperatures to provide design data.

The bubble chamber, a recent invention in the particle detection field (**1, 2**),[1] is a vessel filled with a transparent liquid which can be superheated such that boiling is initiated when a charged particle moves through the liquid. The growth of a visible string of bubbles appears along the particle path. The bubble trails are recorded on stereo photographs a few milliseconds later while they are still very small. A typical photograph of tracks obtained in the 550-liter hydrogen bubble chamber is shown in Fig. 1.

The 550-liter bubble chamber (usually called the 72-in. bubble chamber because of window size) is mechanically supported between the poles of an electromagnet having a field of about 17,000 gauss. The magnetic field deflects the charged particles into curved paths. When the film images are projected, the paths of the particles can be reconstructed. Their directions, lengths, and curvatures indicate what kinds of particles were produced in the various nuclear interactions.

In fundamental particle physics, pure liquid hydrogen is an excellent target material because its nucleus results in relatively simple interactions. A reaction taking place in a mass of hydrogen avoids the confusion that may arise when a high-energy particle strikes a more complex nucleus. Bubble cham-

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

BASCOM W. BIRMINGHAM received a B.S. degree in 1948 and an M.S. degree in 1951 from the Massachusetts Institute of Technology. Mr. Birmingham joined the National Bureau of Standards staff in 1951 as a Mechanical Engineer in the Cryogenic Engineering Laboratory. He is presently Assistant Chief of the Laboratory and Chief of the Cryogenic Processes Section. His field of specialization includes low-temperature processes and equipment, thermodynamics and heat transfer. Since 1955 he has been associated with the hydrogen bubble chamber developments now being reported.

DUDLEY B. CHELTON received a B.M.E. degree in 1948 from the Ohio State University, and a M.S. degree in 1949 from the Massachusetts Institute of Technology. Mr. Chelton joined the National Bureau of Standards staff in 1951 as a Mechanical Engineer in the Cryogenic Engineering Laboratory. His projects with NBS include: the design and construction of hydrogen liquefiers and refrigerators; cryostats for low temperature use; and liquid hydrogen bubble chambers. Mr. Chelton was with the Los Alamos Scientific Laboratory, Los Alamos, New Mexico in 1950 and 1951.

DOUGLAS B. MANN received his B.S. M.E. degrees from the University of Colorado in 1952, and his M.S.M.E., in 1959. Since 1952 he has been on the staff of the National Bureau of Standards as a Mechanical Engineer in the Cryogenic Engineering Laboratory. He has also been one of the NBS consultants in the liquid hydrogen bubble chamber program, a project to give technical assistance to the University of California's Lawrence Radiation Laboratory.

H. P. HERNANDEZ obtained his B.S. degree in mechanical engineering from the University of California in 1943. He has been employed at the Lawrence Radiation Laboratory since August, 1946. He participated in the development of the 4-in., 10-in., and 15-in. bubble chambers. Since February, 1955, he has been project engineer for the 72-in. bubble chamber.

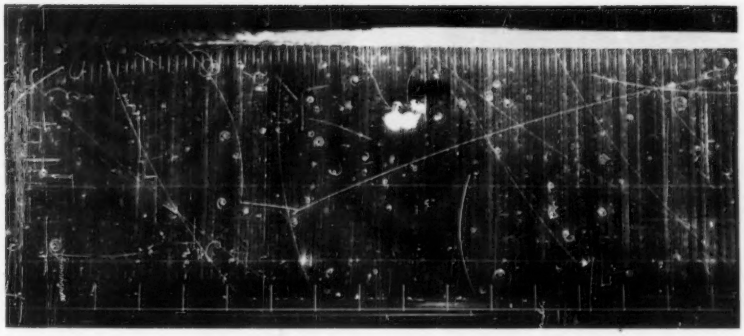

Fig. 1—Typical photograph of tracks in the 550-liter liquid hydrogen bubble chamber.

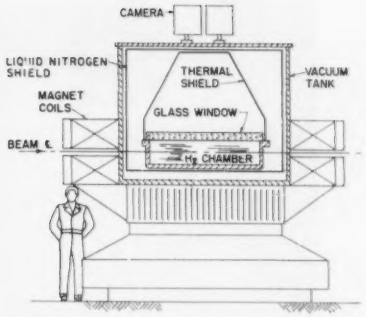

Fig. 2.—Schematic diagram of bubble chamber and magnet assembly.

bers operating with liquids provide high nuclear density as compared to cloud chambers operating with gas.

The design of a bubble chamber using liquid hydrogen involves unusual and difficult low-temperature materials problems. Liquid hydrogen has a triple point of 13.8 deg Kelvin with a pressure of 1 psia. Its critical temperature is 33 deg Kelvin and its critical pressure is about 13 atmos (191 psia) above which no liquid phase is possible. Thus, for a hydrogen-filled bubble chamber to operate successfully, the temperature and pressure must be between these values. Experience has shown that, for best hydrogen bubble chamber operation, the liquid should be maintained at a temperature near 27 deg Kelvin. A pressure of about 6 atmos must be maintained to keep the liquid in a subcooled quiescent state. Superheating is accomplished by suddenly reducing the pressure to about 3 atmos. The reduced pressure state is maintained for approximately 20 to 50 milliseconds.

A liquid-hydrogen bubble chamber must be maintained at a low temperature and must be able to withstand a moderate internal pressure. A large window having good optical properties must be provided on the chamber for observing and photographing particle tracks. Effective thermal insulation must be provided to prevent excessive heat influx. Powder insulation was not considered applicable during development of the bubble chamber because frequent disassembly was anticipated; consequently, high vacuum was selected. A glass-to-metal seal to operate between a pulsating high pressure in the liquid and the insulating vacuum of 10^{-6} mm Hg was required. A thermal radiation shield, maintained at liquid-nitrogen temperature, surrounds the bubble chamber. A schematic view of the bubble chamber and magnet assembly is shown in Fig. 2.

A discussion of these problems and the cryogenic research conducted to help solve them are presented below.

Chamber Material

At low temperatures, austenitic stainless steels are known to remain ductile, have a high strength, and relatively low heat capacity. Thus, these steels are good materials for the construction of equipment and devices that must operate at low temperature (**3**). It was decided to use one of the austenitic series of stainless steel alloys, rather than copper or aluminum for the bubble chamber primarily because of the higher strength. Copper or aluminum could be used as a chamber material and, in fact, they are being considered by other groups developing liquid-hydrogen bubble chambers. A single casting was considered advisable to avoid welding of large plates. An alloy having good machinability, a low magnetic permeability at 27 deg Kelvin, and good casting properties was desired.

Several of the austenitic stainless steels exhibit instabilities on either cooling to or cycling to low temperature (**4**). AISI types 303 and 304 have an appreciable increase in magnetic permeability because of a phase transformation from austenite to martensite. The phase transformation also results in increased notch sensitivity and changes in coefficient of thermal expansion. Figure 3

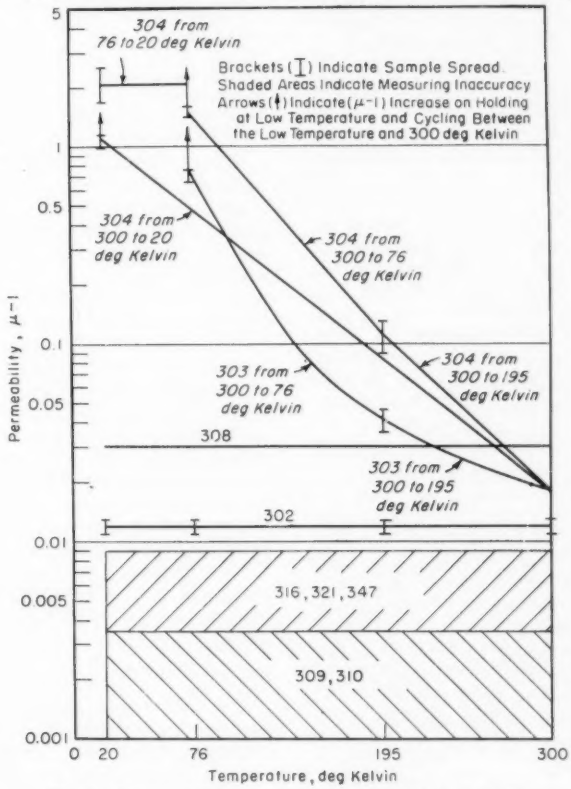

Fig. 3.—Permeability of some austenitic stainless steels.

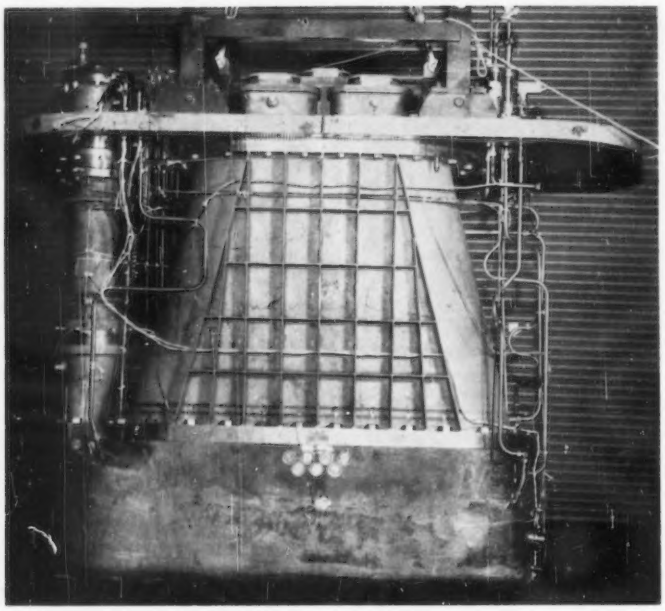

Fig. 4.—Side view of bubble chamber assembly.

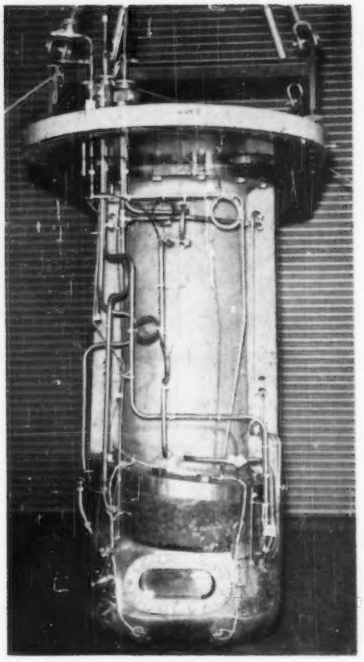

Fig. 5.—End view of bubble chamber assembly.

indicates the effect of temperature on the permeability of annealed stainless steels of the 300 series. Care must be exercised when using these data to predict the permeability at low temperatures since the stability is dependent on the chemical composition. Many of the stainless steels have large nominal composition limits for critical chemical elements. By proper selection of the composition, in particular nickel content, a completely stable stainless steel can be obtained.

The bubble chamber was cast in accordance with ASTM Specification A 351–52 T.[2] The alloy selected was similar to AISI type 316 except for a high nickel content used to increase stability at low temperature. A chamber having a low magnetic permeability at room temperature and at low temperature is required to minimize the distortion of the magnetic field and to permit a complete survey of the magnetic field at room temperature with the chamber removed. A low magnetic permeability will also minimize magnetic forces that would be caused by an accidental collapse of the high magnetic field in which the chamber is suspended. Low temperature magnetic measurements, made by the NBS Cryogenic Engineering Laboratory on the alloy chosen for this application, showed a permeability of less than 1.004.

An analysis of the sprue metal by LRL showed the following chemical composition for the alloy used to cast the bubble chamber:

Chromium, per cent	16.30
Nickel, per cent	14.98
Carbon, per cent	0.06
Manganese, per cent	0.31
Silicon, per cent	0.48
Phosphorus, per cent	0.03
Sulfur, per cent	0.02
Molybdenum, per cent	0.10
Nitrogen, per cent	0.04

A manufacturer's analysis showed slight deviations from the values given above, suggesting nonuniformity in the casting metal. A minimum tensile yield strength of 32,000 psi was specified, and over 38,000 psi was actually obtained.

The casting was heat-treated at 2000 to 2050 F for 6 hr and then quenched in water. The casting was successfully tested hydrostatically at 250 psi, vacuum tested by use of the mass spectrometer method for leak detection, and Freon tested at 50 psi with Halide leak detection equipment. The casting has been successfully cooled to liquid-hydrogen temperature without indication of leakage. Two views of the bubble chamber assembly, removed from the vacuum container, are shown in Figs. 4 and 5. In each view, the bubble chamber casting is shown at the base of the assembly.

Radiation Shield

A metal shield is suspended between the outer vacuum vessel and the liquid-hydrogen-filled bubble chamber to intercept thermal radiation. This thermal radiation shield is maintained at a temperature near −320 F by liquid nitrogen, in contact with one end of the shield. The remainder of the shield is cooled by metallic conduction; consequently, to obtain a low temperature difference, metal of high thermal conductivity must be used. Copper has a relatively high thermal conductivity. However, the method used in preparing the copper has a large effect on its low-temperature thermal conductivity. The thermal conductivity of copper and some copper alloys (5) is shown in Fig. 6. Although phosphorus-deoxidized copper has a high conductivity at room temperature, it is not useful as a low-temperature shield. Electrolytic tough-pitch (ETP) copper was used for the thermal radiation shield of the chamber.

Refrigerator

A refrigerator was designed capable of automatically maintaining the 72-in. bubble chamber at operating temperature. Construction and detailed design work was done by Beechcraft Research and Development Corp., Boulder, Colo. The arrangement of the refrigerator is shown schematically in Fig. 7. A unique balanced-flow heat exchanger development by NBS was incorporated in the design. The details of the heat exchanger design will be reported at a later date (6).

The refrigerator operates on the principle of the simple Linde cycle and has a

[2] 1955 Book of ASTM Standards, Part 1.

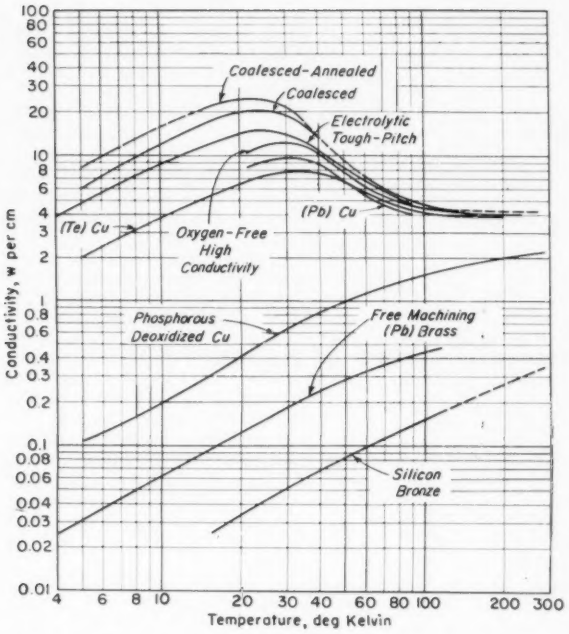

Fig. 6.—Thermal conductivity of copper and some copper alloys.

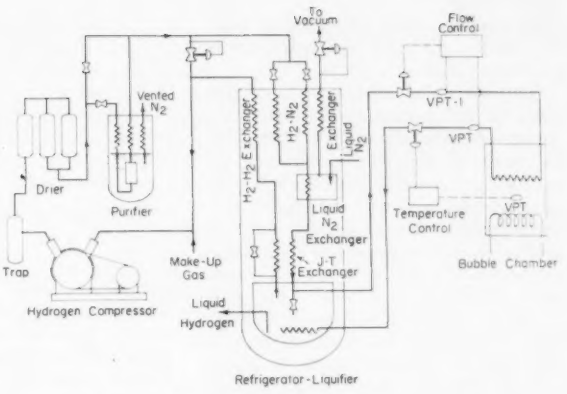

Fig. 7.—Schematic arrangement of refrigerator.

capacity of 1800 w. It is also possible to operate the unit as a liquefier, producing 85 to 100 liters of liquid normal hydrogen per hour. The system utilizes 200 standard cubic feet per minute of hydrogen gas at 1800 psig. Liquid nitrogen is used as a precoolant.

A 300-w refrigerator, using a similar low-temperature process but a different heat exchanger type, has been designed and built by NBS for use with smaller LRL hydrogen-bubble chambers (**7**).

Chamber Window

Both plastic and glass were considered for window materials. For optical quality, the specification limited the bubble inclusions to less than five per square inch of projected area and required that the striae be grade D or better in accordance with specification JAN-G-174. (Striae of grade B or C were actually in the windows as received.) The window is required to withstand a differential pressure between an external high vacuum and a maximum internal pressure of 150 psi in the chamber. The window temperature is that of liquid hydrogen. The window opening is 20 in. wide by 72 in. long. Strength calculations placed the thickness near 5 in.

Plastic was eliminated as a window material on the 72-in. chamber because of the difficulty in casting the required thickness and maintaining satisfactory optical quality. Other factors were the high thermal coefficient of expansion of plastic compared to metals and the low modulus of elasticity. It was felt that the large window-to-metal seal would be a difficult problem with such a large difference in the expansion coefficients. Methyl methacrylate polymers contract about 1.1 per cent when cooled from room temperature to 20 deg Kelvin while stainless steel contracts only about 0.3 per cent. Plastic windows have been used successfully on chambers having windows up to 12 in. in diameter.

Optical glass was considered and a borosilicate crown was selected. The specific type is BSC-517/645. The glass was supplied by Jena Glaswerk Schott und Gen., Optische Abteilung, Mainz, Germany. Selection of this particular type was made on the basis of high coefficient of expansion compared with other optical glass (about one half that of the chamber metal) and a belief by manufacturers that this type could be cast in the thickness desired and meet the bubble and striae specifications mentioned above. This type had previously been used for large diameter optical windows in wind tunnel installations. The thickness used in these installations is comparable to that required on the bubble chamber.

The NBS Cryogenic Engineering Laboratory conducted an experimental investigation to supplement the existing information on the strength properties of BSC-517/645.[3] Information on the strength and fatigue of glass at low temperature (20 deg Kelvin) was obtained and has been reported (**8**). This information was used to compute the window thickness needed to withstand the internal chamber pressure and has also been widely used by others concerned with the development of liquid-hydrogen bubble chambers.

Several relevant facts resulted from the NBS testing of BSC-517/645 glass. The strength of glass, in terms of the stress required to cause fracture, increases with decreasing temperature. At 20 and 76 deg Kelvin, the breaking stress is independent of the rate of loading; at higher temperatures, there is a dependence on the rate of loading. Contact with liquid hydrogen does not appear to reduce the breaking stress.

TABLE I.—BREAKING STRESS OF BSC-517/645 OPTICAL GLASS.

Rate of Stress Increase, lb per sq in. per sec	Breaking Stress, lb per sq in.			
	296 deg Kelvin	194 deg Kelvin	76 deg Kelvin	20 deg Kelvin
800	7500	9500	10400	10400
10	5500	7500	10400	10600
1	5000	6400	10400	10200

The static fatigue of glass, defined as the decrease in breaking stress with increased duration of load, decreases with decreasing temperature. At liquid-hydrogen temperature, BSC-517/645 glass exhibits very little or no fatigue (Table I), and the breaking stress appears to be greater than 10,000 psi. Thus, the stress in low temperature designs can be much higher than room temperature values. However, the limit of all local stresses must be known when designing with glass because local stresses are not relieved by ductility; instead, as deformation occurs, the stress increases along the stress-strain curve until deformation stops or failure occurs.

Glass fails only in tension at the surface. Cooling the window causes temperature differentials that place the glass surface in tension; thus, the cooling must be done slowly to prevent failure.

[3] The Corning Glass Co. furnished the test specimens for the National Bureau of Standards' experimental program.

About 80 hr are required to cool the large window completely, keeping both the cooling rate and the temperature gradients within safe limits.

Thermocouples are located on the glass for monitoring the cooling rate. An investigation was made by the NBS Cryogenic Engineering Laboratory on methods of bonding thermocouples to glass to obtain a true reading of the temperature. Duco cement, diluted with 50 per cent acetone, was found to be an effective bonding agent on clean glass and does not present a removal problem. Although full strength Duco cement and some epoxy resins successfully bonded thermocouples to glass, they presented a problem of chipping the glass during cooling or removal.

Chamber to Window Seals

Several methods of effectively sealing glass windows to bubble chambers operating at a temperature of 27 deg Kelvin have been studied by LRL. Both a direct compression seal for up to 15 in. diameter and an inflatable gasket assembly for the 72-in. bubble chamber (9) have proved successful (Fig. 8). All the seal designs use double gaskets with a pump-out space. The inner gasket is the pressure seal and the outer gasket acts as a labyrinth to provide a pump-out space.

A metal compression shoe and lead pad located on the top glass surface provide a bearing surface for a clamping ring. Since the compression shoe and pad are located radially inside the inner gasket, the internal chamber pressure causes the window to deflect outward, with the compression shoe acting as a pivot. This tends to increase the pressure on the gaskets. Care must be taken to ensure that the tensile stresses on the glass surface caused by the gaskets and compression pad are less than that required to cause failure.

Smaller bubble chambers developed by LRL have used the double gasket compression seal successfully. Lead or indium gaskets can be used in the direct compression seal.

Lead gaskets must be drawn to proper diameter immediately before use to strip hard carbonates from the lead surface. These hard carbonates form on the lead surface after a few hours' exposure to air and prevent vacuum-tight sealing. Indium wire can be used for gaskets as it comes from the spool. In both cases, extreme care must be taken to clean the glass surface, removing any traces of lint or other foreign matter.

The 72-in. hydrogen bubble chamber with a 25 by 75-in. glass window must be sealed with an inflatable gasket (10). The maximum differential contraction between the window and the inflatable

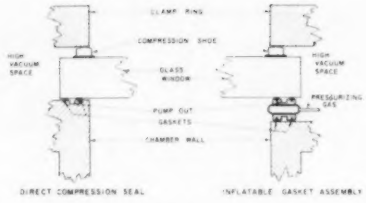

Fig. 8.—Glass to metal seals.

gasket is slightly more than 0.15 in. The inflatable gasket was devised to provide a method of making the seal after cooling the members to be sealed. This prevents surface irregularities from scratching and tearing the gasket as differential expansion occurs. Experience has shown that gaskets of pure indium (99.999 per cent) work best. Indium gaskets must be replaced each time, and great care must be used in cleaning since the metal is hard at 27 deg Kelvin and will accommodate only very slight irregularities.

The inflatable gasket must be deformed slightly at room temperature by inflating the assembly with helium gas pressure. Initial deformation must be made warm since the modulus of elasticity of the gasket materials increases greatly with decreasing temperature. The initial helium gas pressure required for deformation is about 50 psig which results in clamping force sufficiently small to allow virtually unrestricted differential movement between the window and gasket assembly during cooling. When all parts are at the operating temperature, the gasket assembly is inflated to a pressure sufficient to form a vacuum-tight seal. Indium requires 200 to 300 psig for sealing with the present design. The glass compression stress under the indium is about 5.75 times the gasket pressure at 77 deg Kelvin. With the above procedure, the indium has little tendency to adhere to the glass surface. Small traces have been observed on the glass surface, but are easily removed with lens tissue.

Conclusion

Low-temperature measurements of the properties of materials conducted by the NBS Cryogenic Engineering Laboratory have made it possible for the designer of cryogenic equipment and devices to develop designs for low-temperature applications. The LRL liquid-hydrogen bubble chamber is a good example of a new development that required the skillful utilization of many low-temperature properties. References (11) through (21) are given for readers interested in additional details concerning liquid-hydrogen bubble chamber theory, operation, and design.

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Technical Note

Residual Stresses in Heat-Exchanger Tubes

HEAT-EXCHANGER and condenser tubes are widely used by the oil and chemical industries. An estimate of the amount used in oil refineries has shown that approximately 40 ft of tubing is required for each barrel of installed capacity. With refining capacity in the United States of 8 million bbl per day, this amounts to 320 million ft of tubing. The tubes are usually steel, admiralty metal, or 18–8 stainless steel. Size is usually $\frac{3}{4}$-in. OD, 16-gage wall, with lengths running up to 20 ft.

These materials generally perform very well, giving service for 5 to 10 yr and sometimes longer. In some instances, however, the operating life has been very short—a matter of a few weeks. Failure in these instances has not resulted from excessive corrosion but from fine pitting followed by prolific cracking. These cracks are found in both longitudinal and transverse directions, and are typified by a branched transgranular crack indicative of stress corrosion cracking. A photograph of a cracked admiralty metal tube is shown in Fig. 1. The tube had failed after 11 months of exposure to steam condensate which contained 5 ppm of ammonia. Cracks of similar nature have developed in admiralty-metal tubes handling hydrocarbons containing traces of chlorides or sulfur dioxide. Stainless steel cracks in chloride solutions, whereas carbon steel cracks in caustic or nitrate solutions.

To investigate the problem, a subgroup was appointed by Subcommittee IX of ASTM Committee A-1 on Steel. This committee has collected samples of cracked tubing and visited tube mills to investigate manufacturing procedures that could create stresses high enough to induce rapid cracking.

The work to date has shown that annealed tubing is free from appreciable locked-in tensile stresses. However, during roll-straightening operations high residual tensile stresses are developed in both longitudinal and transverse directions. The following table shows the residual hoop stress present in roll-straightened tubes. All sizes are $\frac{3}{4}$-in. OD, 16-gage wall.

Material	Residual Hoop Stress, psi
Admiralty metal (ASTM Spec. B 111)	5500 to 9000
Carbon steel (ASTM Spec. A 179)	4000 to 5000
18–8 stainless (ASTM Spec. A 269)	7000 to 8000

Residual stresses in failed tubes have been measured. The residual hoop stress in a section from a cracked admiralty-metal tube was found to be 4900 psi. This figure appears significant, since it is below the figures shown in the table for admiralty metal as now purchased.

Tests show that residual stresses created by roll-straightening operations can be relieved by reheating at the following temperatures:

Material	Temperature, deg Fahr
Admiralty metal	1100 to 1175
Carbon steel	1150
Stainless steel	1650

Further work is now in progress on methods of producing stress-free tubes that are commercially straight.

G. A. NELSON
Shell Development Co.
Emeryville, Calif.

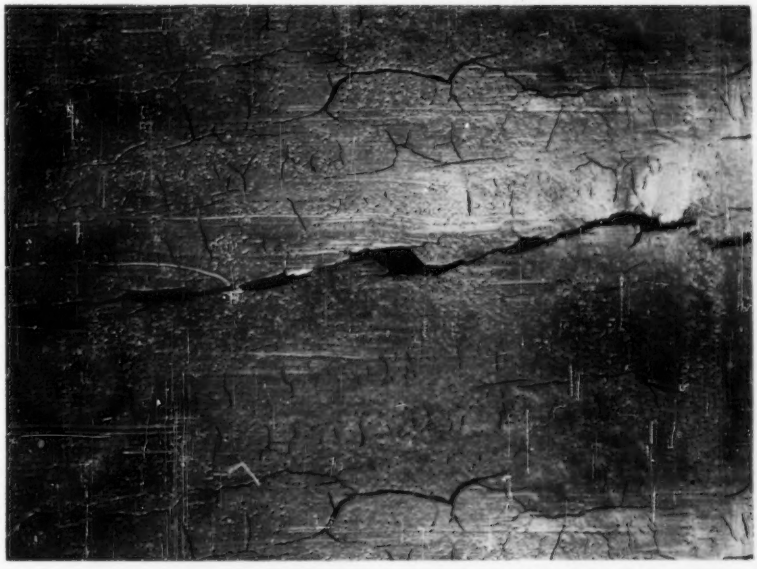

Fig. 1.—Magnified view of cracked brass condenser tube.

Material—admiralty metal (ASTM Spec. B 111). Size—4-in. OD, 16-gage wall. Material handled (outside and inside) steam condensate and steam plus 5 ppm of ammonia. Temperature—not given. Time in service—11 months.

Water-Retardant Qualities of External Coatings

By I. SOROKA

The study was carried out with a view to developing a test procedure for the comparative rating of water-retardant qualities of external coatings under laboratory conditions. Thirteen coatings of different makes were tested using a modified "chimney" method under constant pressure equivalent to 100 mm (approx. 4 in.) head of water. Coatings were applied to sand-lime bricks and the amount of water penetration was recorded daily for periods up to 23 days. This procedure was repeated twice for each specimen—before and after application of the coating.

Comparative rating was based on performance's dependence on the properties of the untreated specimens, as well as on its retardant qualities indicated by keeping penetration below a certain level (considered as corresponding to the amount likely to cause internal dampness in 22-cm wall through header bricks).

Results indicate high water-retardant qualities in silicone coatings in gasoline; sodium silicate solution was the poorest water-retardant coating tested. The author's conclusion is that the suggested test procedure is a reliable means of comparative rating.

General

The different aspects of rain-resistance failure in external walls have been the subject of extensive research by various authorities (1–10)[1] resulting in important recommendations. These, however, are not always observed, and the treatment of the defective walls is usually limited to some kind of external rendering, with some preference for colorless coatings in view of their economic and architectural advantages. Rating the ability of external coatings to improve wall resistance to rain penetration presents a rather complicated problem, mainly due to lack of reliable methods for establishing the correlation between test results and performance in practice. At present, no satisfactory accepted procedure is known, although several methods are used locally with some degree of success.

It was assumed that better progress could be made toward the solution of this problem by carrying out the investigation in successive stages, each of them confined to a limited aspect of the problem. The present paper is a summary of a study carried out at the Building Research Station, Technion, Israel Institute of Technology with a view to developing a comparative test procedure for rating the water-retardant qualities of external coatings.

Selection of Test Method

Test methods generally used are fundamentally of a comparative nature. Although specimens and procedures vary, evaluation is always based, one way or another, on comparing results of treated and untreated specimens. However, to the best of the author's knowledge no attempt has been made to eliminate the effect of fluctuations in specimen properties. This fact was considered a marked disadvantage and was therefore decisive in selecting the test procedure.

Existing test methods can be classified in three general groups: The artificial-rain method, the flat-immersion method, and the "chimney" method.

Artificial-Rain Method (3, 7, 9, 11, 12)

This method is used extensively in testing the watertightness of wall panels and occasionally in testing external coatings. The procedure is generally preferred because its conditions are similar to those prevailing in the exposure of external walls. However, when the study is limited to the comparative rating of water-retardant coatings, it has some marked disadvantages—quantitative tests can only be carried out on wall panels penetrated through their entire thickness and repeatability under identical or controlled conditions is very difficult to achieve owing to the variety of factors involved.

Flat-Immersion Method (13, 15)

This method provides a more suitable procedure for comparative purposes. Even where absorptive properties vary from specimen to specimen, the effect of this variability can be allowed for, since these properties are easy to determine and control in advance.

Its main disadvantage is that under test conditions capillary suction is the predominant factor in the penetration process, to the virtual exclusion of other factors. In practice, these conditions apply to most untreated commonly used building materials where the magnitude of the external forces (wind, gravity) is negligible compared with those of capillary suction (7). For treated materials with water-repellent coatings, on the other hand, both effects are of the same order and neither of them can be neglected. Hence, the immersion method is likely to give misleading results in these cases.

The "Chimney" Method (1, 4)

In this method, test conditions provide for the effects of both capillary suction and external factors. In view of this, and of the repeatability of the tests under desired and controlled conditions, it was adopted for the proposed study.

Test Procedure

Sand-lime bricks were selected as the basic testing material owing to their comparatively wide range of absorption values and resistance to water penetration. Each brick was sawed in two, and each pair marked with consecutive numbers to facilitate identification. In practice, however, corresponding halves were mostly found to differ, so that each had to be tested as a separate specimen.

The instrument used is shown in Fig. 1. A glass cylinder having an inside diameter of 67 mm (approx. $2\frac{3}{4}$ in.) and a height of 300 mm (approx. 12 in.) is attached to the center of the specimen with colophony-based mastic.[2] The cylinder is filled with water and sealed airtight by means of a rubber stopper through which a glass tube of small diameter (approx. $\frac{1}{12}$ in.) is driven.

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[1] The boldface number in parentheses refer to the list of references appended to this paper.

[2] One hundred parts colophy rosin, 25 parts wax and 40 parts ferric oxide (by weight).

ITZAK SOROKA, after graduation from Technion, Israel Institute of Technology, Haifa, Israel, was engaged in site and office work in Israel and the U.S. In 1953 he became research engineer in the Materials Division of the Building Research Station, Technion, Israel Institute of Technology. The present paper is a summarized report based on the study carried out in connection with his M.S. thesis.

TABLE I.—NOTATION OF COATINGS.

	Coating	Notation	Number of Specimens Tested
No. 1	Boiled linseed oil (diluted in kerosine 1:1 by volume)	A1–LO	14
No. 2	Boiled linseed oil (diluted in kerosine 1:1 by volume)	A2–LO	10
No. 3	Sodium silicate (40° Bé)	B–WG	11
No. 4	Cement paint (white)	C1–CP	8
No. 5	Cement paint (white)	C2–CP	10
No. 6	Cement paint (light blue)	C3–CP	9
No. 7	Silicone in gasoline solution (ready-mixed)	D1–S	9
No. 8	Silicone in gasoline solution (ready-mixed)	D2–S	9
No. 9	Silicone in gasoline solution (ready-mixed)	D3–S	9
No. 10	Silicone in aqueous solution	D4–SW	10
No. 11	Emulsified mixture of paraffin, waxes etc.	E1–P	10
No. 12	Emulsified mixture of paraffin, waxes etc.	E2–P	10
No. 13	Emulsified mixture of paraffin, waxes etc.	E3–P	10

This tube is lowered to 100 mm above the specimen surface, and water is drawn through the tube by suction until it is empty, that is, the pressure at the level of its lower end is equalized with the atmospheric pressure, hence the pressure on the specimen surface is equivalent to 100-mm head of water. Additional suction will not change these conditions, as any decrease of pressure below the atmospheric level would introduce air through the tube and restore the original pressure inside the cylinder. The same situation is created when the loss of water is due to penetration through the specimen, and pressure conditions are thus kept constant throughout the test provided the water level in the cylinder is kept above the lower end of the small tube.

The amount of water penetration is read by means of a millimeter scale glued to the outer wall of the cylinder. Reading is started at the moment the desired pressure is achieved and continued, at 24-hr intervals, until a more or less uniform penetration has been obtained, that is a state of equilibrium reached between water penetration and evaporation. This situation is considered to be reached once the fluctuation of the daily readings remains within ±10 per cent of their arithmetic mean for at least five successive days. This arithmetic mean is hereafter referred to as the "final penetration."

Tests were carried out in two stages as each specimen was tested twice—before and after treatment: after testing the untreated specimen it was air-dried, treated with the desired coating, and tested again. Application of the coating was effected by means of a long-handled brush, without removing the cylinder. Amounts of material applied varied between 250 to 400 g per sq m in accordance with manufacturer's recommendations or local practice.

Altogether 13 coatings of different origins were tested. Notation and nature of coatings, as well the number of specimens, tested, are given in Table I.

Results and Evaluation

Coating performance was evaluated in two aspects: capacity for reducing penetration and dependence on specimen properties. The capacity for reducing penetration is undoubtedly a decisive factor in rating water-retardant qualities; but it was considered that rating should not be limited to this aspect only, since the water-retardant qualities should be independent of specimen properties, and any such dependence should be reflected in a lower rating.

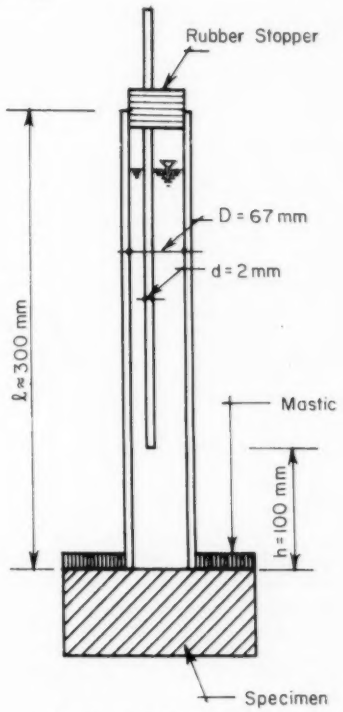


Fig. 1.—Details of instrument.

TABLE II.—COMPARATIVE RATING BASED ON FOUR DAYS PENETRATION.

Coating	Penetration, cu cm per sq cm			Rating
	Minimum	Maximum	Arithmetic Mean	
A1–LO	0.0	7.6	2.1	2
A2–LO	2.4	20.9	12.5	10
B–WG	2.3	36.8	13.3	11
C1–CP	4.6	13.3	8.0	8
C2–CP	1.1	8.3	4.0	5
C3–CP	2.2	17.0	9.3	9
D1–S	0.0	3.8	0.9	1
D2–S	0.3	8.8	3.7	4
D3–S	0.7	10.2	3.6	3
D4–SW	0.8	8.4	3.6	Rejected
E1–P	1.4	10.0	6.2	6
E2–P	3.0	10.2	6.8	7
E3–P	8.4	22.6	14.7	12

Amount of Water Penetration

The amount of water penetration into the treated specimen during the first four days of the test was used for the purpose of comparative rating. It is believed that this period is satisfactory from the viewpoint of local climatic conditions, that is, subjecting the specimen to the suggested test procedure for four days is likely to give the same results as in actual exposure. Nevertheless the figure should be considered as more or less arbitrary, since to the best of the author's knowledge no suitable and proved method exists for determining it otherwise. However, in view of the comparative nature of the study, the problem is not of primary importance.

The amounts of water penetration are given in Table II. In each case three values are presented: the minimum and maximum observed, as well the calculated arithmetic mean for all specimens tested.

Dependence on Specimen Properties

Obviously, only values observed under identical conditions in the treated and untreated specimens, respectively, should be analyzed to establish any possible dependence. As can be concluded from the following evaluation of the penetration *versus* time curves, the final penetration values should be considered the most satisfactory from this point of view.

A typical diagram of water penetration *versus* time is given in Fig. 2. The picture is similar for untreated and treated specimens, although, of course, the corresponding values after treatment are lower.

In some cases (mainly untreated bricks), acceleration of the penetration process could be observed after a period of slowing down. This acceleration usually set in a few days after the beginning of the test, resulting in higher final penetration values—sometimes even ex-

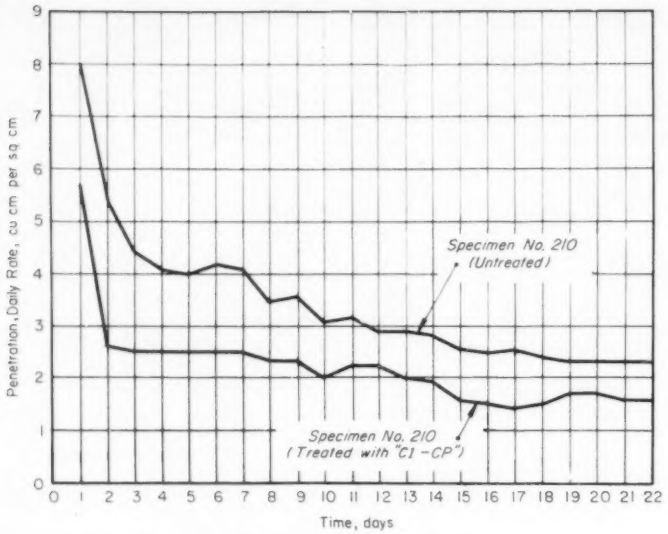


Fig. 2.—Penetration *versus* time.

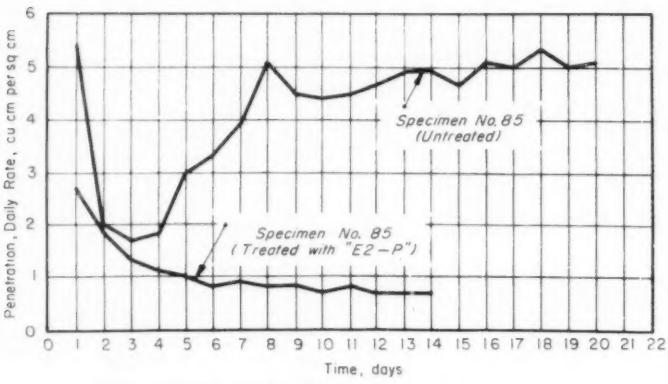


Fig. 3.—Penetration *versus* time.

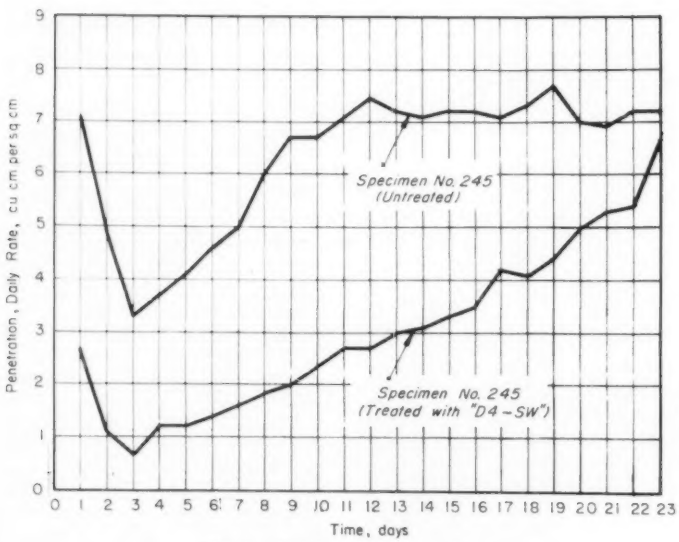


Fig. 4.—Penetration *versus* time.

ceeding the initial values (Fig. 3). A suggested explanation is that water moving through the brick sweeps away loose particles clogging the channels, reducing resistance to penetration and thus resulting in higher values. Wherever this phenomenon was observed in treated bricks, acceleration was smaller than in the untreated specimens.

In these cases the above explanation cannot hold, since had there been suitable conditions for this phenomenon it should have been observed in the untreated stage. A more satisfactory explanation can perhaps be found in the effect of the coating in hindering penetration. As a result of this effect, the rate of water movement through the lower layer is higher than that of the penetration allowed by the coating. This leads to partial drying of the upper layers and in turn increases penetration until equilibrium is established.

One more explanation could be the partial deterioration of the coating under exposure to water. This, however, would imply a progressive (or at least continuous) process—which was not the case here. In fact, only silicone in aqueous solution (D4 – SW) seemed to behave in a manner suggesting deterioration (Fig. 4) and was therefore rejected at this stage of the study.

Taking into consideration the varying time pattern of the water penetration, it can be seen that up to the point of constant penetration its rate is governed by numerous factors that are likely to differ in the different specimens, so that even parallel values cannot be compared under these conditions. On the other hand, constant penetration is achieved due to equilibrium between the factors involved, hence these values—final penetration values—should be considered for evaluation.

As already explained, the final penetration value is the arithmetic mean of the penetration observed when the fluctuation of daily readings remains within ±10 per cent of this mean. The calculated final penetration values for different coatings are given in Tables III and IV, while in Figs. 5(*a*) and 5(*b*) the final penetration values of the treated specimens are plotted against the respective values of the untreated ones.

Generally speaking, the results indicate two trends: while some coatings reduce the amount of penetration to certain values regardless of the respective values of the untreated specimens (Table III), in others this effect seems to be related to the amount of penetration observed in the untreated specimens (Table IV).

Statistical methods were applied[3] to

[3] For methods used see A. Hald, "Statistical Theory with Engineering Applications," Ch. 18, John Wiley & Sons, Inc., New York (1952).

TABLE III.—FINAL PENETRATION AND RATING OF UNCORRELATED COATINGS.

Coating	Conditions	Final Penetration, cu cm per sq cm														Arithmetic Mean	Rating
		1	2	3	4	5	6	7	8	9	10	11	12	13	14		
A1–LO	Untreated	1.82	2.48	2.02	2.13	1.26	1.65	2.81	4.15	1.74	2.60	2.97	4.67	3.15	2.14		
	Treated	0.65	0.53	0.03	0.74	0.50	1.08	0.37	1.16	0.34	0.07	0.07	0.75	0.11	0.58	0.498	4
C2–CP	Untreated	1.71	1.75	0.88	0.85	1.23	0.96	1.16	1.96	2.18	2.26	...	...	...	...		
	Treated	0.44	0.15	0.15	0.45	0.33	0.46	1.03	0.38	0.25	0.70	...	...	...	...	0.434	2
D1–S	Untreated	18.15	4.10	3.85	14.99	6.71	13.35	2.90	5.44	5.97	...	...	...	...	...		
	Treated	0.02	0.03	0.03	0.14	0.04	0.03	0.03	0.07	0.05	...	...	...	...	...	0.049	1
D2–S	Untreated	7.64	10.04	4.07	5.42	11.72	6.73	5.64	4.99	3.00	...	...	...	...	...		
	Treated	0.25	0.44	0.05	0.19	0.66	0.94	0.93	0.10	0.41	...	...	...	...	...	0.441	3
D3–S	Untreated	10.74	2.60	5.13	10.02	4.11	1.97	6.26	5.44	3.37	...	...	...	...	...		
	Treated	0.96	0.43	0.41	0.57	1.03	0.23	0.36	0.47	0.74	...	...	...	...	...	0.577	5
E1–P	Untreated	7.96	1.40	0.91	10.52	3.09	15.30	7.42	4.86	3.57	4.83	...	...	...	...		
	Treated	0.93	0.78	0.78	0.77	0.94	1.15	1.17	0.74	0.72	0.48	...	...	...	...	0.846	6
E2–P	Untreated	13.68	5.89	5.00	1.88	2.77	7.80	5.76	15.80	4.97	9.25	...	...	...	...		
	Treated	0.57	0.63	0.90	0.90	0.87	1.03	1.29	1.18	0.77	1.00	...	...	...	...	0.914	7

TABLE IV.—FINAL PENETRATION AND RATING OF CORRELATED COATINGS.

Coating	Conditions	Final Penetration, cu cm per sq cm											Regression Line	Rating
		1	2	3	4	5	6	7	8	9	10	11		
A2–LO	Untreated	5.06	11.46	6.92	8.88	2.70	1.10	2.42	4.16	4.65	7.14	...		
	Treated	3.76	5.68	6.61	4.53	2.12	0.40	1.77	3.59	1.57	2.85	...	$y = 0.48x + 0.655$	9
B–WG	Untreated	10.20	13.99	10.09	7.43	1.26	1.20	2.48	1.67	1.16	0.52	5.16		
	Treated	9.79	14.07	7.09	5.60	1.00	1.07	1.98	1.28	0.99	0.52	4.81	$y = 0.93x - 0.262$	12
C1–CP	Untreated	2.17	1.24	0.64	1.21	1.50	1.57	1.75	2.40	...	...	...		
	Treated	1.22	0.76	0.44	0.52	0.96	1.00	1.24	1.58	...	...	...	$y = 0.65x - 0.052$	10
C3–CP	Untreated	2.00	2.78	1.18	1.30	1.25	1.48	2.16	1.95	1.16	...	...		
	Treated	1.56	0.19	0.74	0.80	0.97	1.01	1.43	1.46	0.86	...	...	$y = 0.68x + 0.040$	11
E3–P	Untreated	10.55	13.40	15.31	7.14	12.40	14.31	12.14	12.51	4.21	9.41	...		
	Treated	2.44	3.17	4.73	2.17	3.40	4.33	4.08	3.61	1.76	2.60	...	$y = 0.25x + 0.422$	8

find out possible dependence of the final penetration values of the treated specimens on the respective values of the untreated ones. Results agreed with the above-mentioned trends and justified classification in two groups. The first group, which consists of the coatings for which no dependence was found, is referred to hereafter as the "uncorrelated group" while the second is referred to as the "correlated group." For the correlated group, the relationship between treated and untreated values was found to be linear and the respective regression lines are also given in Table IV.

Comparative rating is effected by comparing the mean final penetration of the treated specimens for the uncorrelated group, and the slope of the regression lines for the correlated group (Tables III and IV).

It should be noted that ratings obtained on this basis are not always in agreement with ratings based on the amount of water penetration (Table II). This can be explained by considering the varying time pattern of the penetration discussed earlier.

Over-all Rating

It was considered that better-quality coatings should reduce water penetration below the level likely to cause the appearance of dampness on the inner face of an external wall and that this reduction should be unrelated to the penetration before the treatment. However, the "level likely to cause the appearance of dampness" should be determined before the final rating can be obtained.

For this purpose a 22-cm wall built of 22 by $10\frac{1}{2}$ by $8\frac{1}{2}$-cm sand-lime bricks was considered. Preliminary tests were conducted in order to find out the amount of water that such bricks can absorb without the appearance of dampness opposite the exposed face, for example, under conditions similar to header bricks in a 22-cm thick exposed external wall. In these tests 43 oven-dry bricks were placed upright in water 6 mm (approx. $\frac{1}{4}$ in.) deep. The amount of water absorbed was determined by weight at the moment dampness appeared at the upper face. For the same bricks the "absorption capacity," that is, the amount of water absorbed during 48-hr immersion in cold water, was also determined. The amount of water absorbed up to the appearance dampness is referred to as the "critical level of absorption." Results are given in Table V in which the critical level of absorption is given as percentage of the absorption capacity.

As can be seen the minimum value of the critical level of absorption may be regarded as 60 per cent. Thus, for the local sand-lime bricks with an average volume weight of 1651 kg per cu cm and absorption capacity of 16.74 per cent the amount of water penetration per unit area sufficient to bring up the moisture content to the critical level is:[4]

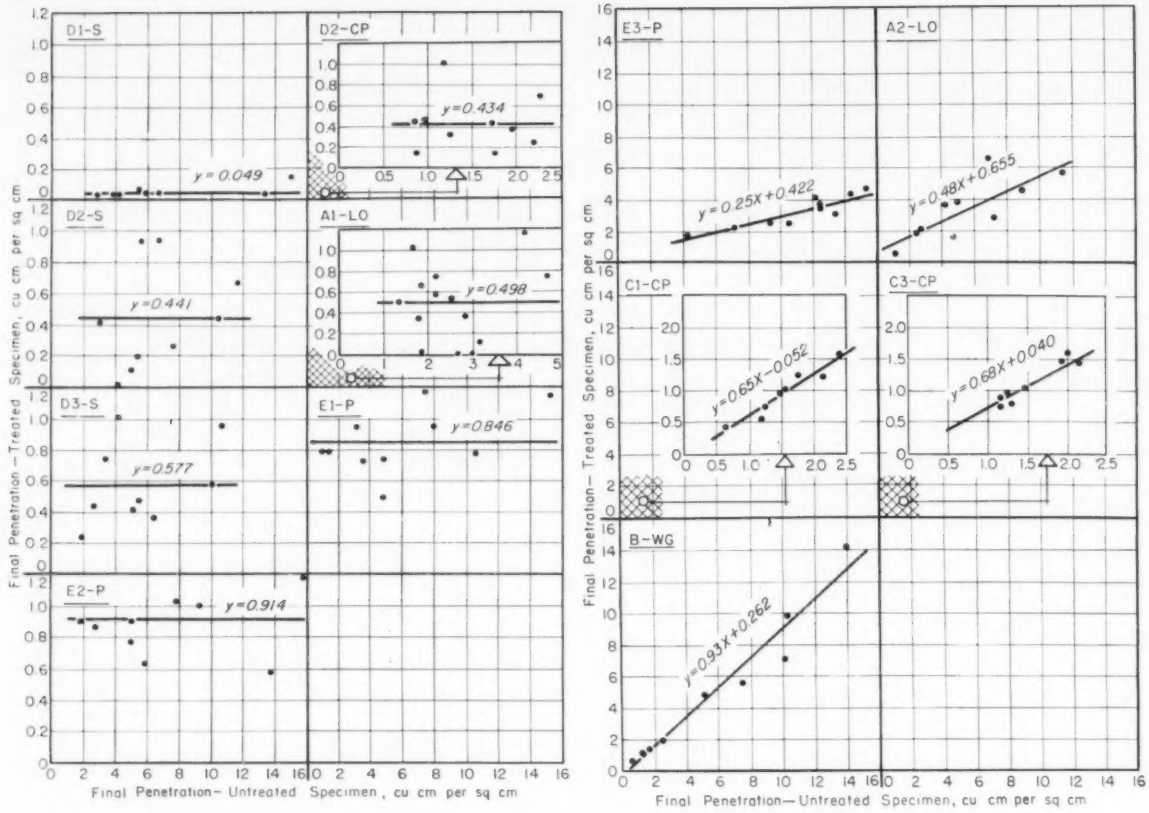
TABLE V.—CRITICAL LEVEL OF ABSORPTION.[a]

No. 1.....63.2	No. 12.....77.9	No. 23.....69.0	No. 34.....68.2
No. 2.....71.7	No. 13.....81.7	No. 24.....66.1	No. 35.....78.1
No. 3.....71.3	No. 14.....67.7	No. 25.....75.7	No. 36.....79.2
No. 4.....63.2	No. 15.....76.0	No. 26.....76.2	No. 37.....64.5
No. 5.....73.5	No. 16.....74.8	No. 27.....77.0	No. 38.....68.7
No. 6.....66.5	No. 17.....82.7	No. 28.....66.0	No. 39.....72.7
No. 7.....66.8	No. 18.....72.1	No. 29.....72.7	No. 40.....68.8
No. 8.....66.7	No. 19.....66.0	No. 30.....73.0	No. 41.....64.2
No. 9.....47.4	No. 20.....65.7	No. 31.....74.5	No. 42.....62.6
No. 10.....58.7	No. 21.....65.6	No. 32.....77.7	No. 43.....73.6
No. 11.....82.5	No. 22.....65.9	No. 33.....67.6	

$n = 43$, $\bar{X} = 70.3$ per cent, $\sigma = 6.78$ per cent.

[a] Given as percentage of absorptive capacity.

[4] Assuming that the effect of evaporation of moisture build-up is negligible.



(a) (uncorrelated coatings—grades A, B, and C).

(b) (correlated coatings—grade D).

Fig. 5.—Final penetration of treated *versus* untreated specimens.

$$\frac{22.0 \times 1.0 \times 1.0 \times 1.651 \times 16.74 \times 60}{100 \times 100} = 3.8 \text{ cu cm per sq cm}$$

As already stated, under the suggested test procedure, the period of four days was assumed to correspond to the effect of actual exposure and therefore penetration values given in Table II were used for rating.

Taking everything into consideration the comparative rating of the coatings was based on the following proposed grading:

Grade A—Uncorrelated coatings for which the amount of water penetration for all specimens tested was below the critical level (3.8 cu cm per sq cm over four days—Table II).

Grade B—Uncorrelated coatings for which the amount of water penetration for some specimens was above the critical level while the arithmetic mean remained below it.

Grade C—Uncorrelated coatings for which the amount of water penetration for some specimens as well as the arithmetic mean were above the critical level.

Grade D—Correlated coatings irrespective of the amount of water penetration.

The grading of coatings tested are given in Table VI.

TABLE VI.—GRADING OF COATINGS

	Coating	Rating
No. 1	A1-LO	B
No. 2	A2-LO	D
No. 3	B-WG	D
No. 4	C1-CP	D
No. 5	C2-CP	C
No. 6	C3-CP	D
No. 7	D1-S	A
No. 8	D2-S	B
No. 9	D3-S	B
No. 10	D4-SW	Rejected
No. 11	E1-P	C
No. 12	E2-P	C
No. 13	F3-P	D

Discussion and Conclusions

The author's conclusion is that the suggested procedure is a reliable means of comparative rating of the water-retardant qualities of external coatings. The method used eliminates the influence of specimen properties, while the rating is based on the actual reduction of water penetration as well as the dependence on the above properties

Although compared with a built-in brick, the penetration area is rather small while the evaporation area is large, this should not be regarded as a disadvantage in view of the comparative character of the test.

As all coatings were applied without removing the cylinder, a question may be raised as to the possibility of difference in performance, if any, along the boundary line of the coating with the cylinder.

Although the actual effect cannot be deduced from the available data, still, considering the results obtained, the author is of the opinion that it is limited and unlikely to affect the rating considerably.

Within the narrow terms of reference of the study, results clearly indicate the higher quality of silicone coatings in gasoline solution, the other types being comparatively inferior. This conclusion is generally in line with test results and the experience of other authors.

Acknowledgment:

The author is indebted to R. Shalon, head of the Building Research Station, Technion, Israel Institute of Technology, under whose supervision and guidance the study was carried out, and to R. C. Reinitz for taking an active part in the statistical analysis of the results.

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Discussion of a Paper on a Method of Test for Potential Efflorescence of Masonry Mortar[1]

Mr. Leo Kampf.[2]—Efflorescence is not only unsightly; it can cause destructive expansion. But more important, it is an indication of a brick-to-mortar joint that is not tight. It is therefore highly desirable to have a simple laboratory test such as that suggested by Mr. Rogers. However I think Mr. Rogers has pointed out the weakness in the proposed method when he says, "The occurrence of efflorescence depends on many factors other than the composition of the mortar." I wish to discuss some of the "other" factors.

Chemically, I think it is a mistake to group all efflorescence together. I think we should differentiate between what I would call "temporary" and "permanent" efflorescence.

"Temporary" efflorescence would be that which is caused by soluble salts (from the cement, sand, brick, or water); "permanent" efflorescence would be caused by insoluble salts. This is caused principally by the calcium hydroxide that comes either from the lime, hydrolysis of the portland cement, or from the fillers in masonry cements. The lime in contact with carbon dioxide in air forms the insoluble calcium carbonate.

In the proposed method the wicks and mortar are set in 50 ml of distilled water. At the end of the test the wicks are broken off and the salts dissolved in 250 ml of distilled water. The solubilities of some of the compounds causing "permanent" efflorescence are:

Compound	Solubility, g per 100 ml of water at indicated temperature
$Ca(OH)_2$	0.185 (0 C), or 0.077 (100 C)
$CaSO_4$	0.209 (30 C), or 0.1619 (100 C)
$CaCO_3$	0.0014 (25 C), or 0.0018 (75 C)
$Mg(OH)_2$	0.0009 (18 C), or 0.004 (100 C)
$MgCO_3$	0.0106 (20 C)

This indicates that that under the conditions of this test very little of these salts can be dissolved. If the efflorescent weight loss in Table I of the paper is plotted against the total water-soluble alkali in Table II, a curve that is very nearly a straight line will result. No such relation exists with the acid-soluble alkalies. It is therefore probable that the method is dependent principally on the water-soluble alkalies.

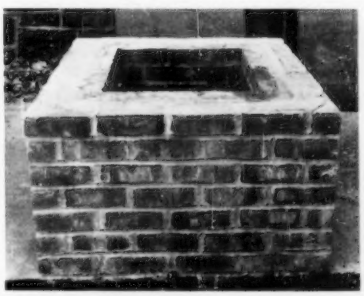

Fig. 1.—Soft brick with 1:1:6 lime mortar.

Fig. 2.—Soft brick with 1:3 masonry cement.

[1] P. L. Rogers, "A Method of Test for Potential Efflorescence of Masonry Mortar," ASTM BULLETIN No. 235, Jan., 1959, p. 31 (TP 1).

[2] Principal Chemist in Charge, Borough of Queens, Office of President, Kew Gardens, N.Y.

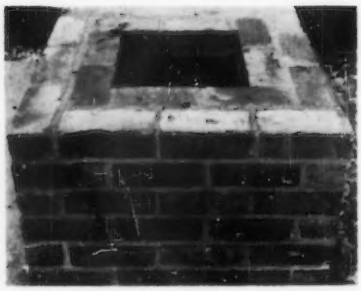

Fig. 3.—Soft brick with 1:6 mortar with additive.

Fig. 4.—Hard brick with 1:1:6 lime mortar.

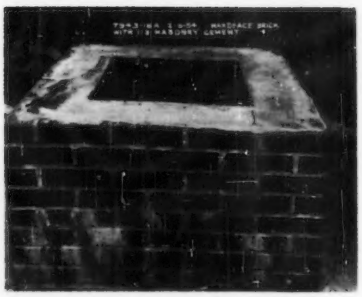

Fig. 5.—Hard brick with 1:3 masonry cement.

Any laboratory method for the determination of efflorescence must as far as possible duplicate those conditions which result in this phenomenon. The mechanism of efflorescence consists of water entering openings between the mortar and the brick, dissolving soluble salts in the mortar, and depositing them on the face of the brick. The water-soluble alkalies contribute to temporary efflorescence, and the calcium hydroxide combining with carbon dioxide in the air contributes to the permanent efflorescence. Those properties of a mortar which affect the bond between the mortar and the brick affect efflorescence. The two most important are workability and water retention. If either is low it is impossible to obtain a tight joint, and efflorescence will be high.

We have tried many methods to determine efflorescence—wicks, flower pots, cross-brick in water—but none have given a good correlation with efflorescence in a wall. The only test that does give a good correlation is the brick box. While it is not a simple laboratory method, it does indicate the nature of efflorescence.

Brick boxes were constructed with soft brick, using three different mortars (Figs. 1, 2, and 3). Two of the same mortars were used in boxes made with hard (low absorption) brick (Figs. 4 and 5). The hard-brick boxes show the nature of efflorescence a little better than the soft-brick boxes. The effloresecing salts tend to diffuse on the surface of the soft brick and mask the source of the efflorescence. The hard-brick boxes show the efflorescence starting at the interface between the brick and the mortar, especially at the vertical joint, and depositing on the face of the brick.

I think therefore that a laboratory method that in some way duplicates the brick boxes might give results that correlate better with efflorescence in a wall. These take into account most of the factors contributing to efflorescence. The wick test takes into account only those chemicals which contribute to temporary efflorescence. It is probably similar to the staining test.

Mr. P. L. Rogers (*author's closure*).—The discussion by Mr. Kampf is a valuable contribution to the subject of efflorescence. However, it makes desirable some explanation and comment by the author.

Design, construction, and maintenance are important factors in the development of efflorescence on masonry. This is generally recognized but too often necessary details are neglected. Poor workmanship and inadequate protection of walls under construction permit excessive amounts of water to enter the structure. Inadequate and leaky gutters are at times the primary cause of serious efflorescence. These are some of the many factors other than the composition of the mortar that influence the development of efflorescence.

Mr. Kampf makes a point of separating efflorescence into two types—temporary and permanent. He classifies recarbonated lime as a permanent type, that is, one that is not readily soluble in water. Dr. Anderegg[3] considered lime as a special case of efflorescence that is brought to the surface mostly when new masonry has become saturated. However, lime may be brought to the surface at later periods if water percolates and filters through the masonry. Such a condition reveals a defect in the structure that needs correction. The subcommittee, in its effort to provide a method of test for potential efflorescence of masonry mortar, did not attempt to provide a method that would gage the extent to which lime would cause efflorescence. All cementitious materials normally used in mortar of this type contain considerable quantities of lime or liberate lime during the hardening process. Faulty structural conditions may result in its appearance. It may be readily removed but first the structural defect should be remedied.

It would seem that brick boxes built upon slabs of concrete which in turn rest upon the ground would not be a trustworthy method of testing the masonry for efflorescence. It is assumed that the boxes are filled with water as one step in the test procedure.

The use of certain additives that entrain air reduce the tendency of mortar to efflorescе. This was found to be true by the proposed method of test and experience with various masonry materials in use confirms this.

[3] F. O. Anderegg, "Efflorescence," ASTM BULLETIN No. 185, Oct., 1952, p. 39 (TP 155).

Low-Temperature Tensile Properties of Copper and Four Bronzes

By R. M. McCLINTOCK, D. A. VAN GUNDY, and R. H. KROPSCHOT

The tensile properties of oxygen-free high conductivity copper in both the hard temper and annealed conditions, a half-hard beryllium bronze, a half-hard beryllium cobalt bronze, a one-quarter-hard silicon bronze, and full-hard grade C phosphor bronze, have been measured at temperatures between 20 and 300 Kelvin (−424 and +80 F). Tensile strength, yield strength, and modulus of elasticity generally increased with decreasing temperature for these materials. The silicon bronze, however, showed a lower value of modulus of elasticity at 20 Kelvin than at 76 Kelvin (−323 F). Ductility increased with decreasing temperature except for the phosphor bronze, which exhibited a decrease as temperature decreased from 76 to 20 Kelvin.

THE chances of a designer of cryogenic equipment finding engineering data on which to base his design are still somewhat uncertain, especially below 76 Kelvin. Even the face-centered cubic metals and their solid solution alloys, accepted as the safest metals for general application at very low temperatures because of their retention of ductility, have received only spotty coverage to date.

Certainly the reliability of cryogenic equipment bears a close relationship to the availability of engineering design values. (Rocket and missile components are current examples of cryogenic equipment which must have exceptionally high reliability.) For this reason the Cryogenic Engineering Laboratory of the National Bureau of Standards has been conducting research on the problems of low-temperature engineering. The present study is part of a program of this laboratory on mechanical properties data at low temperatures.

The mechanical, thermal, optical, and electrical properties of copper and its alloys at low temperatures make these materials desirable for use in many cryogenic applications. In the design of cryogenic laboratory apparatus or engineering equipment, for example, a material may be required which will have high thermal and electrical conductivity and low magnetic susceptibility, as well as sufficiently good mechanical properties to be a load-bearing part of the structure. When, in addition, the ease of assembling the equipment by soldering or brazing is considered, copper or one of its alloys is often the best choice the designer can make. The selection of both composition and condition of the metals chosen for this research was made to fulfill a requirement for design values for a liquid hydrogen-cooled electromagnet.

Description of Test Specimens

Oxygen-free high conductivity copper and grade C phosphor bronze were obtained from commercial suppliers in $\frac{3}{4}$-in. diam bars, and tensile specimens were machined from this stock to $\frac{1}{4}$-in. diam test sections. Oxygen-free high conductivity copper was obtained also in the form of 0.010-in. foil and $\frac{1}{8}$-in. square wire. The test coupons made from the foil had a width of $\frac{1}{2}$-in. at the test section, and those made from the $\frac{1}{8}$-in. square wire were machined so that the test area was 0.080 in. square in cross-section. The beryllium bronzes and the silicon bronze were obtained as $\frac{1}{8}$-in. sheet and were machined to give a rectangular cross-section in the test region of nominal dimensions $\frac{1}{2}$ by $\frac{1}{8}$ in. The long axis of the specimens was parallel to the direction of rolling for all the sheet specimens, and no stock was removed from the rolled surfaces of the sheets.

The basis of elongation measurements was 1 in. for the specimens made from bar, 2 in. for those made from sheet and foil, and 1.2 in. for those made from wire.

The compositions of the bronzes tested were determined by chemical analysis, and the physical conditions of the bronzes and the copper designated by the suppliers were verified by hardness measurements and photomicrographs of the unstressed material. Comparison with published commercial tolerances shows the actual chemical compositions of the alloys to be within commercial limits, except for the grade C phosphor bronze which falls about 1 per cent short of ASTM Specification

R. MICHAEL McCLINTOCK received his M.S. degree from the University of Colorado. For six years he has been with the Cryogenic Engineering Laboratory of the National Bureau of Standards in Boulder, Colo., where he has been engaged in research on the mechanical properties of solids at low temperatures.

DONALD A. VAN GUNDY received his M.S. degree in 1957 from the University of Colorado. He has been a mechanical engineer at the Cryogenic Engineering Laboratory of the National Bureau of Standards since 1953, where he has been engaged in the study of mechanical properties and cryogenic fluid transfer systems.

R. H. KROPSCHOT received his Ph.D. degree in physics from Michigan State University. He has conducted research in cryogenic physics and cryogenic engineering for nine years at North American Aviation and at the National Bureau of Standards.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

B 139[1] for copper content (see Table I).

The oxygen-free high conductivity copper bar was received in the hard temper condition as indicated by a diamond pyramid hardness (DPH) of 119 (Rockwell hardness B 57), and it was machined and tested without further treatment.

The copper foil was received in the annealed condition, and the specimens were cut from the parent sheet in mutually perpendicular directions and given a further treatment of 473 Kelvin (200 C) for 8 hr in a helium atmosphere. This material had an average grain size of 0.014 mm in transverse section. The jig shown in Fig. 1 was used for the tests on the foil. Its function was to guide the ends of the specimen axially as tension was applied. Prior to its use, initial elongation at one or the other edge of the specimen led to premature failure by tearing, and the consequent indications of tensile strength were low and somewhat scattered.

The copper wire was also tested in the annealed condition. Its diamond pyramid hardness was 67 (Rockwell hardness F 49), and measurements made from photomicrographs showed it to have an average grain size of 0.011 mm in transverse section. The specimens were soft-soldered into jigs, with precautions being taken to keep the center section cool during the soldering operation to prevent oxidation.

The beryllium bronze, silicon bronze, and phosphor bronze alloys were given no treatment before testing other than machining to size. Table II is a summary of the condition of the materials tested.

Experimental Methods

The apparatus used to obtain the tensile data was a standard hydraulic tensile testing machine with additional equipment for conducting tests at cryogenic temperatures. The essential addition was the arrangement of an insulating Dewar vessel to permit immersion of the test specimen in a cryogenic medium during the tensile test. Tension rods extended through the top and bottom of the container, and chain linkage was interposed between these rods and the specimen to minimize bending loads. The cryogenic medium could be either liquid or gas, with the temperature of the specimen controlled automatically by a refrigerating device actuated by a thermocouple attached to or near the specimen. In the present series of tests, however, the temperature was maintained constant by the use of boiling liquids at 76 and 20 Kelvin (nitrogen and hydrogen, respectively). The temperature of 195 Kelvin was obtained using solid carbon dioxide, with methylcyclohexane as a heat transfer medium.

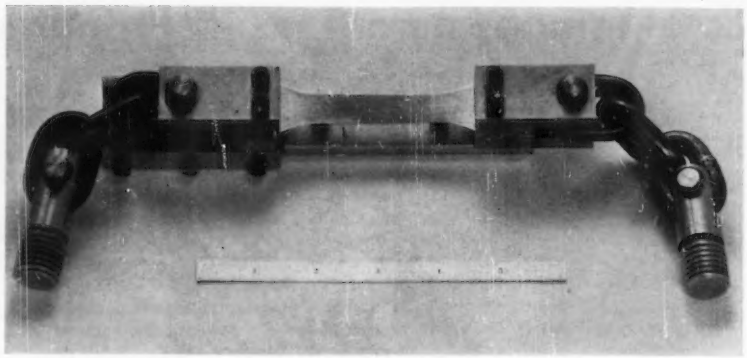

Fig. 1.—Foil tension test jig.

Hoke, Mabus, and Goller (1)[2] have shown that the temperature increase of a tensile specimen caused by the absorption of strain energy can be considerable for metals having a large capacity for work hardening. Temperature measurements were made, therefore, of a copper tensile specimen as it was pulled in air at room temperature to determine whether a heat transfer medium better than the surrounding air was required to maintain a constant specimen temperature for the tests made at ambient conditions. These measurements indicated that for the strain rates used in this study a negligible temperature increase takes place even at the region of necking, where the maximum energy is dissipated. This is probably due to the greater thermal diffusivity of copper alloys than the alloys used by Hoke, *et al.*, some of which exhibited a temperature increase of 50 to 100 F during testing.

Wire resistance strain gages were cemented to each specimen and used to measure the strain as a function of the applied stress. The appropriate corrections for the change in strain sensitivity factor with temperature have been applied (2). An exception to this technique was made in the case of the copper wire specimens. The strain was not measured on the copper wire because the test section was too small to allow gages to be attached.

The modulus of elasticity and yield strength data presented were obtained by graphical methods from the stress-strain relationship for each specimen.

TABLE I.—CHEMICAL ANALYSIS OF BRONZES TESTED.

Element	Beryllium Bronze	Beryllium Cobalt Bronze	Silicon Bronze	Phosphor Bronze, Grade C
Copper, per cent	97.7	96.8	95.8	90.3
Tin, per cent	...	...	...	8.2
Silicon, per cent	0.08	0.05	3.1	...
Beryllium, per cent	1.9	0.51	...	...
Cobalt, per cent	0.21	2.6	...	...
Iron, per cent	0.07	0.05	...	...
Phosphorus, per cent	...	...	...	0.06
Manganese, per cent	...	...	0.86	...
Lead, per cent	...	...	<0.01	None detected

TABLE II.—PHYSICAL CONDITION OF SPECIMENS.

Material	Diamond Pyramid Hardness (DPH)	Rockwell Hardness	Condition
Oxygen-free high conductivity copper bar	119	B 57	hard
Oxygen-free high conductivity copper foil	...	...	annealed
Oxygen-free high conductivity copper wire	67	F 49	annealed
Beryllium bronze	228	B 98, C 17	half-hard
Beryllium cobalt bronze	144	B 73	half-hard
Silicon bronze	154	B 78	one-quarter hard
Phosphor bronze	273	B 100, C 22	hard

[1] ASTM Specification for Phosphor Bronze Rod, Bar and Shapes, 1958 Book of ASTM Standards, Part 2, p. 231.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

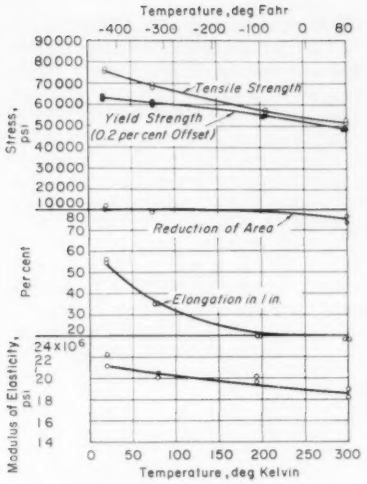

Fig. 2.—Tensile properties of hard-drawn oxygen-free high conductivity copper bar as a function of temperature.

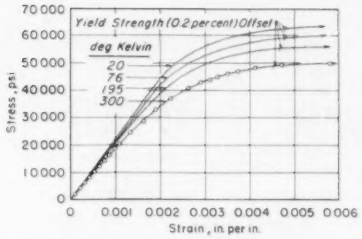

Fig. 3.—Typical stress-strain curves for hard-drawn oxygen-free high conductivity copper bar at several temperatures.

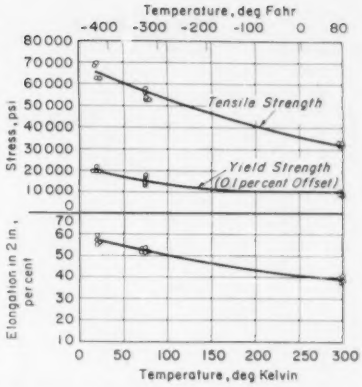
Temperature, deg Fahr
-400 -300 -200 -100 0 80
Stress, psi
Tensile Strength
Yield Strength (0.1 per cent Offset)
Elongation in 2 in., per cent
0 50 100 150 200 250 300
Temperature, deg Kelvin

Fig. 4.—Tensile properties of annealed 0.010 in. oxygen-free high conductivity foil, parallel to the direction of rolling, as a function of temperature.

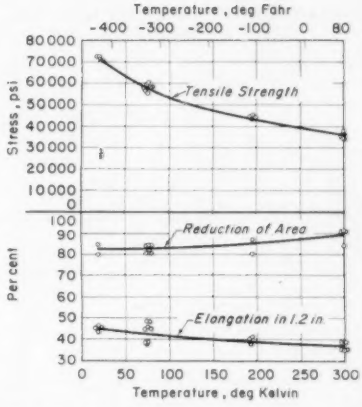

Fig. 5.—Tensile properties of annealed oxygen-free high conductivity copper wire as a function of temperature.

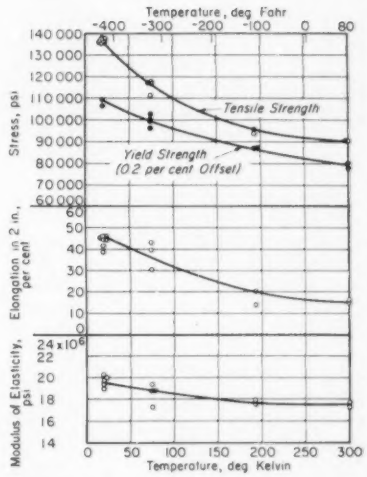
Temperature, deg Fahr
-400 -300 -200 -100 0 80
Stress, psi
Tensile Strength
Yield Strength (0.2 per cent Offset)
Elongation in 2 in., per cent
Modulus of Elasticity, psi
24 x 10^6
0 50 100 150 200 250 300
Temperature, deg Kelvin

Fig. 6.—Tensile properties of one-half-hard beryllium bronze as a function of temperature.

Yield strength obtained in this way is not very sensitive to the previously mentioned temperature effect on the sensitivity of the strain gages. The modulus of elasticity recorded, however, is directly affected by a change in gage sensitivity, so the accuracy of modulus figures depends on the accuracy with which gage sensitivity can be predicted at the test temperature. Similar gages have been calibrated at the temperatures mentioned, but the prediction of gage sensitivity for any given gage in use on a tensile specimen depends on the validity of the assumption that all gages in the same package have the same change in sensitivity with temperature. We have found this to be true within ±2 per cent for the gages used in these measurements by investigating a number of gages, but to this error must be added the supplier's ±1 per cent tolerance in gage factor at room temperature.

All of the metals were tested at a strain rate of approximately 0.0005 per min up to their yield strengths, and approximately 0.02 per min beyond.

Discussion of Results

In general, the face-centered cubic metals, their solid solution alloys, certain body-centered hexagonal metals, and the austenitic stainless steels (also face-centered cubic) retain sufficient ductility to be desirable as structural materials at cryogenic temperatures. However, copper is one of the few metals exhibiting an increase in ductility with decreasing temperature (**3, 4, 5**). Figure 2 shows the tensile properties of hard-drawn oxygen-free high conductivity copper as functions of temperature. The increase in yield and tensile strength with decreasing temperature, typical of homogeneous solids, is apparent, as well as the greater elongation at low temperatures. (In all the graphs of tensile results, each point shown represents data obtained from one specimen.) Typical stress strain curves for this material are shown in Fig. 3. Points at which data were taken are omitted from the low temperature curves to avoid cluttering the graph.

Figure 4 shows the tensile properties of annealed oxygen-free high conductivity foil parallel to the rolling direction. The tensile strength in the perpendicular direction is the same as in the parallel direction at all temperatures; however, the yield strength (which was taken at 0.1 per cent offset for the foil), in the perpendicular direction is slightly lower than in the parallel direction. These results show that even after annealing there exists a preferred crystal orientation detectable at low temperatures. From the results of Boas (**6**) one would expect to observe slightly higher yield strength in the direction parallel to rolling. (To save space the strength data perpendicular to the direction of rolling are not shown graphically.)

Figure 5 gives tensile results for the oxygen-free high conductivity copper wire. The slight difference in valves from those of the foil probably reflect partially the difference in average grain size of the two materials.

Figures 6, 7, 8, and 9 show the tensile properties of one-half-hard beryllium bronze, one-half-hard beryllium cobalt bronze, one-quarter-hard silicon bronze, and full-hard grade C phosphor bronze. These results show that the tensile strength, yield strength, modulus of elasticity and elongation increase with decrease in temperature. Exceptions are a slight decrease in ductility of the phosphor bronze as the temperature is lowered from 76 to 20 degrees Kelvin, and an unexplained decrease in modulus of elasticity of the silicon bronze in the same temperature range. The results shown in Figs. 6 and 7 are in substantial

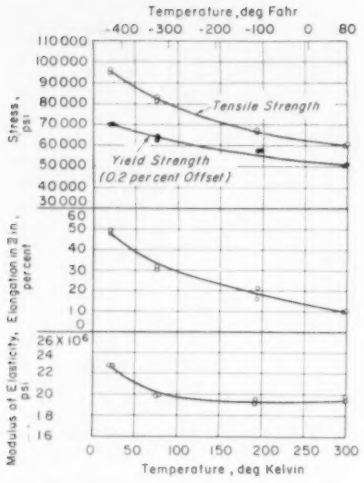

Fig. 7.—Tensile properties of one-half-hard beryllium cobalt bronze as a function of temperature.

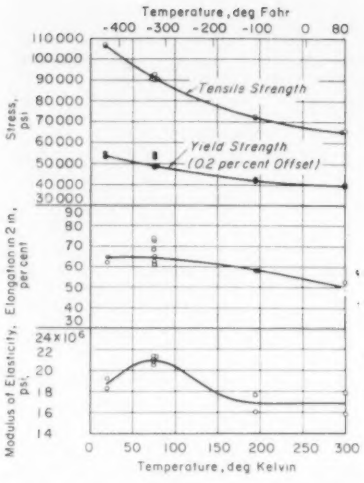

Fig. 8.—Tensile properties of one-quarter-hard silicon bronze as a function of tem-aperture.

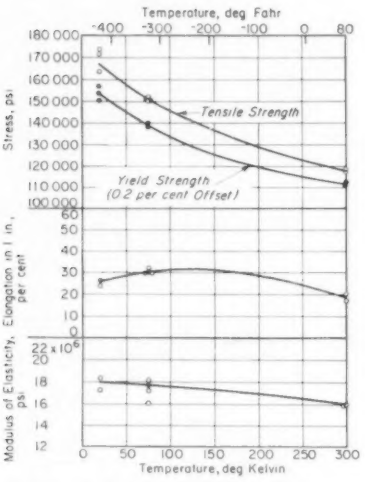

Fig. 9. Tensile properties of full hard grade C phosphor bronze as a function of temperature.

agreement with previous results, except that a significantly greater elongation was observed at the lower temperatures for half-hard beryllium bronze than that reported by Richards and Brick (**8**).

Typical broken tensile specimens for all the materials investigated show a ductile fracture and plastic deformation of the entire reduced section. These results qualitatively support the data on ductility presented in the graphs.

The temptation to compare elongation and reduction of area figures among the alloys presented is worth a word of caution. The measured values of these properties are known to depend upon the size and conformation of a tensile specimen (**7**), so it is misleading to attempt comparison of the ductility of different alloys on the basis of these properties when, as in the present case, the specimens used were of unlike geometry. For example, a glance at the elongation curves for the copper foil and wire (materials which are very similar metallurgically) show differences which can probably be attributed at least in part to the different geometry of the specimens. However, since a ductility figure is seldom used in a quantitative way by a designer, the important thing from his viewpoint is that none of these α-phase alloys exhibit a transition to brittle behavior at low temperatures when tested under uniaxial stress conditions.

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Technical Note

A New Steel for Aircraft and Missile Honeycombs

WHEN THE X-15 rocket plane—scheduled to carry a man into the near reaches of space shortly—plunges back into the earth's atmosphere, air friction will heat its skin to approximately 1000 F. Yet the skin of this half-plane, half-missile will not be damaged by this thermal shock that would pull ordinary aircraft material apart. That is because the plane's surface embodies a new kind of structure that has helped to make supersonic flight possible—the all-stainless-steel honeycomb.

In essence, the honeycomb is composed of strips of metal rolled to "thinnesses" three times thinner than a human hair, joined together at their nodal points after being crimped into a zigzag pattern. The result is the typical apiary design familiar to all honey fanciers. These cells constitute the "core" of the honeycomb. Somewhat thicker sheets of metal on each side of the core complete the honeycomb sandwich—and it is this sandwich which forms the skin of our multiple-Mach craft.

The honeycomb is the strongest known architectural form. It provides an extremely high strength-to-weight ratio. It is because of this that aircraft designers can specify relatively heavy steel for their craft. And the use of steel is, of course, the secret of aircraft that must survive in the intense heat of the "thermal barrier."

Several steels have been developed to meet the special requirements of aircraft honeycombs. The newest—and in many ways, the best—is PH 15–7 Mo.[1]

Properties of PH 15–7 Mo Stainless Steel

This new metal is an offshoot of the chromium-nickel stainless steels. The chromium-nickel steels cannot be hardened by heat treatment, and without such hardening they cannot meet the strength demands made by the aeronautical engineer. To meet these demands PH 15–7 Mo was developed. Although related to the 300 series, it, together with 17–7 PH and 17–4 PH, comprises a new class of precipitation-hardening alloys.

This steel has excellent fatigue properties and high tensile properties. Its corrosion resistance in conditions TH 1050 and RH 950 is superior to the stainless steels of the 400 series. In condition CH 900, its corrosion resistance is comparable to type 302.

PH 15–7 Mo stainless steel is obtainable in two conditions: condition A (annealed), or condition C (cold-rolled). The fabricator can heat treat the steel in either condition.

Condition A

Condition A is obtained at the mill by annealing at 1950 ± 25 F and then air-cooling. This gives maximum softness and ductility; therefore it is preferred for severe forming operations. Like AISI type 301, PH 15–7 Mo, condition A has a high work-hardening rate. In forming deep-drawn parts or intricate shapes, reannealing by the fabricator is sometimes necessary before heat treating to condition TH 1050. No anneal is necessary, however, prior to heat treatment to condition RH 950. In condition A, PH 15–7 Mo exhibits typical strength values of: tensile strength—130,000 psi; yield strength (0.2 per cent offset)—55,000 psi.

Heat Treatment for Condition A

The heat treatment of this steel in condition A is a two-step process. In the first step, condition A is transformed into condition T. In condition T, the tensile strength of the alloy has been raised from 130,000 to 145,000 psi, and the yield strength from 55,000 to 95,000 psi. The strength can be increased further, in the second step.

With the part in condition T, the fabricator can now harden within a fairly wide range of temperatures—in fact, anywhere between 950 and 1100 F. This second step is the actual precipitation hardening. When material is hardened in this manner, it is designated as condition TH XXX, where the XXX stands for the temperature of the precipitation-hardening treatment. Condition TH 1050 for example, exhibits a typical tensile strength of 210,000 psi. Its yield strength is about 200,000 psi.

In condition TH 1050, the strengths are somewhat lower than in condition TH 950 (both tensile and yield strengths about 15,000 psi less). This slightly lower strength, however, is more than compensated for by increased resistance to heat and corrosion, as well as a considerable increase in ductility.

By varying the temperature of the second step of the heat-treating process in the range of 950 to 1100 F, the engineer can create at will a whole series of properties. He can determine in advance just what properties he needs, then get what he wants by adjusting the temperature of the hardening process.

Condition C

Condition C is an extremely strong variant of the stainless steel. It possesses a typical tensile strength of 220,000 psi. The typical yield strength is 190,000 psi. The steel in this condition, however, is severely cold-rolled, has little ductility, and is therefore unsuitable for forming difficult parts from flat-rolled sheet or strip.

Condition C can be further heat treated to provide even greater strength. This is achieved by heating to 900 ± 10 F for 1 hr in air. The material which emerges is known as condition CH 900. It is the strongest variant of PH 15–7 Mo. Typical yield strength for condition CH 900 is 260,000 psi; typical tensile strength is 265,000 psi. In thin-gage strip, tensile strengths frequently reach 300,000 psi.

Sub-Zero Hardening

There is a new heat treatment which, because it involves cooling to −100 F, is known as the deep-freeze method.

Starting with condition A, the material is first treated at 1750 ± 15 F for 10 min, then air-cooled. It is then further cooled to −100 F and held at that temperature for 8 hr. It is now in condition R 100 (refrigerated at −100 F).

The third and final step in the process occurs when the alloy is heated to 950 ± 10 F for 1 hr and air-cooled. The final condition is RH 950 (refrigerated and hardened at 950 F). By this method, typical tensile strengths of 240,000 psi and yield strengths of 215,000 psi can be obtained.

In PH 15–7 Mo stainless steel, the engineer has a material which, with the proper heat treatment, will transform into a metal that will very likely satisfy the demands of the newest designs on his drawing board.

ALLEN C. GILBRAITH
New York, N.Y.

[1] Armco Steel Corp., Middletown, Ohio.

Municipal Incinerator Refractories Practice

By R. B. ENGDAHL and J. D. SULLIVAN

Modern, large, continuously fired municipal incinerators are so designed as to provide enough cooling air to keep maximum flame temperatures well below safe operating-temperature limits of available refractories. However, fluctuating loads can effect rapid temperature changes causing refractory damage, and intermittently fired incinerators frequently are overloaded. The excess of air normally supplied then makes it possible for the excess refuse charged to burn far above design rate with resulting higher temperatures and consequent overheating of refractories. When that charge is burned, the excess air rapidly cools the refractories. Damage to refractories also results from intermittent burning operations. Metal and other slag-making constituents in refuse also have a deleterious effect on refractories service. The properties of available refractories as applied to municipal incineration are discussed. A table showing all ASTM specifications and test methods to evaluate the properties of refractories for incinerator use is included.

THE refractories service conditions imposed by large, continuously operated incinerators, as incorporated in most recent designs, are within the performance capabilities of readily available refractories. This stems from two facts: first, that rapid heating and cooling are minimized and, second, that combustion and, hence, exhaust gas odor elimination, are achieved completely if the gases attain only a modest temperature, variously stated to be in the neighborhood of 1600 F. However, ability to withstand temperature is only one of the criteria required in a refractory. Many incinerators suffer refractory damage because fluctuating temperatures cause thermal spalling. In addition, tramp material in garbage can aggravate slagging.

A safe minimum gas temperature during active combustion can be assumed to be 1800 F. However, a hydrocarbon or cellulose type of fuel, such as mixed refuse, having a heat value of 5000 Btu per lb has a theoretical stoichiometric flame temperature of approximately 3100 F. Refuse of 10,000 Btu, dry basis, is not unusual in cities like New York. Because of the widespread use of frozen foods and garbage disposals, the percentage of garbage in refuse has dropped markedly. Hence, some means is needed to reduce the actual flame temperature to a practical level. Although excess air as a coolant has disadvantages, it is used almost universally for reducing flame and furnace temperatures. The cost of air is only that of pumping it into the furnace and amortization of equipment; the available supply is ample. To reduce a 3100 F stoichiometric flame to 1800 F, neglecting furnace heat losses, requires an excess of air 125 per cent greater than that theoretically required. Because of heat losses, the actual excess required is less. Almost all incinerators, large or small, either by design (1)[1] or through leakage, operate with air ranging from 100 to 200 per cent or more in excess within the furnace. The resulting decreased flame temperature *per se* are reasonably safe for good refractory service.

However, despite careful design to assure moderate temperatures, in many incinerators refractories' service is not good. At localized areas, they may sag as a result of overheating caused by the impingement of intense flame. Slag adhesion to the refractories may become so severe that cleaning is required with consequent breakage of the refractories when the slag is chopped off. Why do these conditions exist?

The reason often lies partly in variability in the rate of feed of refuse to the furnace and partly in the potentially high combustion rate which is inherent in a generous air supply. In some cases, localized maldistribution of fuel and cooling air may be responsible. Also slagging of certain materials which commonly enter incinerators may be unavoidable.

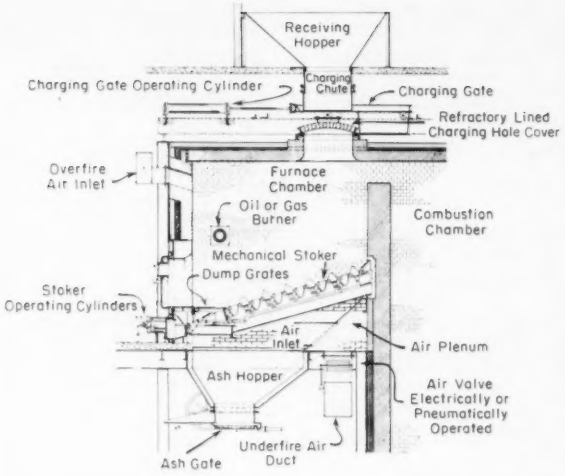
If an incinerator is fed completely mechanically, there is an upper limit on feed rate. The feed equipment operates to provide uniform fuel supply to the furnace within the capacity limits of its design. However, if the feed system is operated manually, its maximum rate is dependent greatly on the skill, alertness, or industriousness of the operator. Hence, manually controlled charging equipment can greatly overload a furnace, and, although the operator may not always realize it there usually is ample air to burn the overload which he imposes. If mixing of the excess fuel and air is good, there may be no smoke resulting from the excessive combustion rate. If fly-ash collection is reasonably good, or if there are few discriminating neighbors, the excessive rates may bring no outside complaints. Even management may be lulled for a brief period by the attractive figures of tonnage handled. The net effect, however results in higher temperatures with resultant adverse effects on refractories.

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

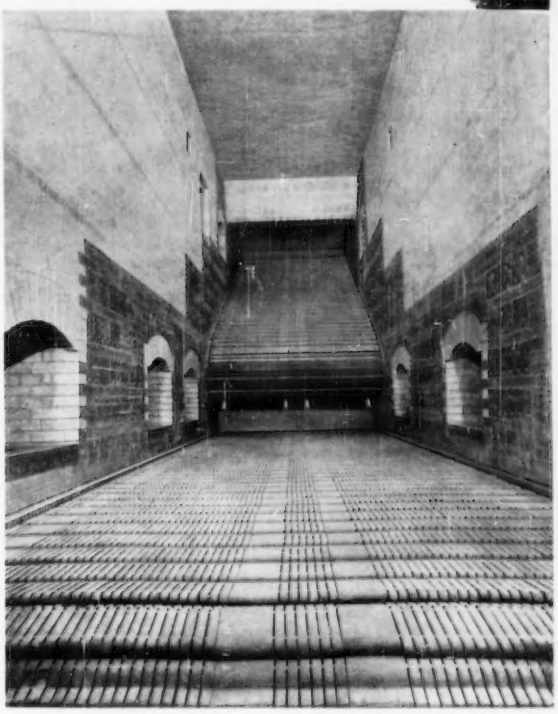
RICHARD B. ENGDAHL, chief, thermal engineering division, Battelle Memorial Institute. Investigations have included applications of pulverized coal; overfire jets for smoke abatement; combustion on spreader stokers; development of low-pressure-loss duct collectors; area air-pollution measurements; fume collection and filtration; incineration; use of model techniques in flow research.

JOHN D. SULLIVAN, technical director, Battelle Memorial Institute, has been active in ASTM since 1934 and was chairman of Committee C-8 on refractories from 1936 to 1948. Currently he is chairman of its subcommittee on specifications and its section on load, and is a member of the advisory committee. He has been active in other societies, including the American Ceramic Society, of which he was national president in 1947–1948, and AIME.



Pittsburgh-Des Moines Steel Co.

Fig. 1.—Elevation of furnace for intermittently charged incinerator.



Pittsburgh-Des Moines Steel Co.

Fig. 2.—Interior view of furnace of large continuously fired incinerator.

Problems of Intermittent Operation

After week-end shutdowns, supplementary fuel, such as gas or oil, may be used to heat the furnace rapidly. The thermal shock may be too severe for the refractories in the installation. However, supplemental fuel can be used to heat the refractories gradually after a shutdown and thus avoid too rapid heating by combustion of dry refuse. Many incinerators do not operate 24 hr per day. At peak rates, combustion may take place in parts of the system never intended to experience combustion, such as against the target wall at the base of the firebrick-lined stack. Tramp metal and other slag-making constituents commonly in refuse aggravate attack on refractories. The sum of these practices lessens the refractories life.

Even where feeding is reasonably uniform, thermal spalling of refractories can become an important source of deterioration if fluctuating plant load causes large variation in furnace temperature. The problems of spalling from intermittent firing of a medium-size incinerator were well described in 1954 in an article (2) on the two 3-ton-per-hr units at the National Institutes of Health.

Types of Furnaces

Although at one time a multiple-hearth furnace, similar in many respects to traditional ore-roasting furnaces, was the most widely used type of incinerator for municipal refuse, and although there are more of this type than of any other still in use, most new large incinerators employ a moving-grate mechanism.

Figure 1 shows an elevation of the furnace of an intermittently fired incinerator. Figure 2 shows an interior view of the furnace of a large continuously fired municipal incinerator.

Problems of Size

Keeping the flame and furnace temperatures moderate in a uniformly fired large incinerator becomes increasingly difficult as the size increases. There are two reasons for this: (1) As the size increases, the surface-to-volume ratio decreases so that proportionately less furnace wall is available for dissipation of the heat released. (2) Greater care in design is needed to assure good distribution of the cooling air throughout the furnace. The center of the flame especially is likely to lack sufficient air for cooling it to the desired average temperature. Consequently, in very large incinerators, unless overfire air is well distributed, the impinging flame which leaves the furnace and meets a bridgewall or arch may be nearer to theoretical stoichiometric temperature than to the design average. Temperature control in larger units has become more difficult because of the change in character of refuse in recent years. The use of frozen foods, the increased use of paper packaging, and the widespread employment of garbage disposals have lowered the moisture content of refuse and increased its Btu value. Some designers use sidewall and roof air jets to reduce the temperature variable and to complete combustion before the bridgewall. In some plants, water jets are played on bridgewalls to cool them. In large continuously fired incinerators, burned bonded silicon carbide refractories as well as slag-resistant super duty fire-clay brick, are used near the grate line to reduce slag attack and adhesion.

Effect of Incinerator Wall Construction

Most incinerators employ solid wall construction. The interior firebrick walls are self-supporting and may be covered on the outside by one or two courses of common brick or by insulating brick and a steel casing. Thermal expansion can be a serious problem with large units, and some means to relieve stresses must be provided. As incinerators become larger, there is a tendency to use a suspension type of wall and roof construction. Although this type of construction has a high initial cost, repairs are easier to make and damaged areas can be replaced rapidly and simply.

In this method the refractories are supported from an exterior structural steel framework (3). Michaels (4) published an extensive tabulation prepared by W. A. Xanten, Division of Sanitation, Washington, D. C., showing the principal features of 25 large municipal incinerator plants. Seven of the 25 used suspended wall construction in the furnace. Most of the seven

TABLE I.—GENERAL SERVICE CONDITIONS OF MUNICIPAL INCINERATOR REFRACTORIES.[a]

Furnace Part	Temperature Extremes, deg F	Slagging	Spalling	Fly-Ash Adherence	Mechanical Shock	Abrasion	Remarks
Primary furnace							
Grate level to 36 in. above	70 to 2600	Severe	Severe	Important	Severe	Severe	Adhering clinker greatest in this zone.
Roof	700 to 2600	Unimportant	Important	Important	Unimportant	Unimporant	Dust settling on roof must be guarded against.
Main furnace walls	70 to 2600	Moderate	Moderate	Unimportant	Moderate	Moderate	...
Charging hole	Atmospheric and higher	Unimportant	Severe	Unimportant	Severe	Severe	...
Stoking doors	70 to 2600	Important	Severe	Unimportant	Severe	Severe	...
Combustion chamber							
Flue	1200 to 2200	Unimportant	Unimportant	Moderately important	Moderately important	Unimportant	Erosion may occur.
Side walls	1250 to 2200	Unimportant	Unimportant	Important	Unimportant	Unimportant	...
Roof	1250 to 2200	Unimportant	Unimportant	Important	Unimportant	Unimportant	...
Expansion chamber							
Flue	1250 to 2600	Unimportant	Unimportant	Moderately important	Unimportant	Unimportant	...
Chamber	1250 to 2600	Unimportant	Unimportant	Moderately important	Unimportant	Unimportant	...
Stack	1000 to 1500	Unimportant	Unimportant	Unimportant	Unimportant	Unimportant	Flash temperatures may reach values up to 2600 F.

[a] Based on Table I, Manual of ASTM Standards on Refractory Materials, p. 376 (1957).

also used suspended construction in the cooler parts of the system such as dust-settling chambers and flues. Meissner (5) has pointed out that the increasing use of suspended construction, use of silicon carbide in slagging areas, and water-cooled furnaces where justified should result in the incinerator being available for service practically 100 per cent of the time.

Summary of Service Conditions

Aside from abuse by overheating in poorly regulated plants, the selection of the wrong refractories for a given installation can be serious. This paper reviews the properties of available refractories as they apply to medium and large incinerators, principally municipal.

Table I is adapted from the Manual of ASTM Standards on Refractories.[2] This table summarizes the service conditions which occur at different parts of incinerators. It is evident that various properties of refractories are required depending on their location in the system.

Refractories, Properties, and Specifications

Table II lists the current ASTM specifications for fireclay refractories that are used in municipal or industrial incinerators. There are three types of refractories used: (1) brick and shapes, (2) plastics, and (3) castables. In addition, there is a specification for mortars for laying up brick and shapes. As used in ASTM terminology, an air-setting mortar is one which may require tempering with water to attain the desired consistency and which is suitable for laying refractory brick and bonding them strongly on drying and on subsequent heating at furnace temperatures. Castables are products which, when tempered with water, develop structural strength by reason of a hydraulic set. Service at temperatures, say, of 1700 F, between the dehydration of the hydraulic set and the formation of a ceramic bond in place must be avoided. Plastics are refractory products which are rammed or otherwise mechanically applied to build furnace parts. In ASTM specifications for incinerator refractories, high duty plastic refractories are designated for average service conditions; super duty plastic refractories for the highest temperature zones and where severe thermal spalling or slagging is encountered and especially where both spalling and slagging may occur to an unusual extent. Plastic firebrick ordinarily are heat-setting and require heating above a minimum temperature to develop a ceramic bond in place. In some instances, they contain chemical additives to effect air-setting.

High duty, medium duty, low duty, and semi-silica brick are defined fairly accurately by the properties specified as shown in Table II. Semi-silica brick has the added requirement that its modulus of rupture be a minimum of 300 psi and that the minimum silicon dioxide content be 72 per cent.

The pyrometric cone equivalent (P CE) is a measure of the refractoriness of the refractory and is defined in ASTM Definitions C 71, as the number of the standard pyrometric cone whose tip touches the supporting plaque simultaneously with a cone of the refractory material being investigated, when tested in accordance with Method C 24.[3]

Deformation under load involves the resistance to deformation or shear of refractory brick when subjected to a specified compressive load at a specified temperature for a specified time. It measures not only the ability of a refractory to bear load at elevated temperatures but also is an index of the refractoriness of a brick. In the case of fireclay brick, it gives an indication of the amount of liquid phase present. This is important in evaluating the resistance of a refractory to slagging.

Certain refractories when heated have a tendency to exhibit a permanent linear change. Some refractories tend to shrink, others to expand. In ASTM the property usually is termed reheat change and in some specifications a maximum reheat shrinkage is specified.

Fireclay brick has a tendency to spall when subjected to changes in temperature. The ASTM Methods C 107[4] and C 180[5] used for incinerator refractories measure the resistance to the separate and combined effects of structural and thermal spalling. As defined by Definitions C 71, thermal spalling is caused by stresses resulting from nonuniform dimensional changes of the unit produced by a difference in temperature; structural spalling is caused by stresses resulting from differential changes in the structure of the unit. The ASTM panel spalling tests

[2] "Survey of Refractory Service Conditions in the Incineration of Refuse," Manual of ASTM Standards on Refractories, Am. Soc. Testing Mats., Eighth Edition, p. 376 (1957).

[3] Method of Test for Pyrometric Cone Equivalent (PCE) of Refractory Materials, 1958 Book of ASTM Standards, Part 5, p. 349.

[4] Method of Panel Spalling Test for High Duty Fireclay Brick, 1958 Book of ASTM Standards, Part 5. p. 300.

[5] Method of Panel Spalling Test for Fireclay Plastic Refractories, 1958 Book of ASTM Standards Part 5, p. 304.

TABLE II.—FIRECLAY REFRACTORIES USED IN MUNICIPAL INCINERATORS.

Service	ASTM Specification	Refractory	Type	PCE, min	Deformation in Load		Reheat Shrinkage		Panel Spalling		Modulus of Rupture, psi, min	Water Content		Workability Index		Drying and Firing Shrinkage		Particle Size		Refractoriness, Shall Not Flow at, deg Fahr
					Max per cent	deg Fahr	Max per cent	deg Fahr	Max per cent	Preheat, deg Fahr		Max per cent	Basis	Min per cent	Max per cent	Max per cent	deg Fahr	−40 mesh, per cent	+20 mesh max per cent	
Zones of high temperature: Main body, crown, target walls	C 106	Brick	High duty or semisilica	31½[a]	1.5[a]	2460	1.5	2550	15	2910	...	...	...	...	...	...	...	...	...	...
Chimneys		Brick	Medium duty (unless otherwise specified)	29[a]	3.0[a]	2460	...	...	...	...	500	...	...	...	...	...	...	...	...	...
			High-duty	31½[a]	1.5[a]	2460	1.5	2550	15	2910	...	...	...	...	...	...	...	...	...	...
			Low duty	19	...	...	...	...	...	...	600	...	...	...	...	...	...	...	...	...
Average service	C 176	Plastic	High duty (unless otherwise specified)	31	...	...	...	...	15	2910	...	15	Wet	15	35	4.0	2550	...	...	...
Zone of highest temp and where spalling or slagging is severe		Plastic	Super duty	32½	...	...	...	...	5	3000	...	15	Wet	15	35	2.5	2910	...	...	...
Construction and Repair Where temp will not exceed 2700 F	C 213	Castable	Class C	...	...	...	1.5	2500	...	...	300 (after drying)	...	...	...	...	...	...	...	...	...
Where temp will not exceed 2400 F		Castable	Class B	...	...	...	1.5	2300	...	...	300 (after drying)	...	...	...	...	...	...	...	...	...
Mortars for laying up fireclay refractories	C 178	Air-setting, wet type	Super duty	...	...	...	...	...	...	...	200 (after drying)	25	Wet	...	...	...	...	95	0.5	2910
			High duty[b]	...	...	...	...	...	...	...	200 (after drying)	25	Wet	...	...	...	...	95	0.5	2730
			Medium duty	...	...	...	...	...	...	...	200 (after drying)	25	Wet	...	...	...	...	95	0.5	2550
ASTM test method				C 24	...	C 16	C 113 for Specification C 106 C 269 for Specification C 213		C 107 for Specification C 106 C 180 for Specification C 176		C 133 for Specification C 106 C 268 for Specification C 213 C 198 for Specification C 178	C 92		C 181		C 179		C 92		C 199

[a] Only one of these two requirements must be met.
[b] Unless otherwise specified, high duty shall be supplied.

are not intended to measure mechanical spalling which is defined as that caused by stresses resulting from impact or pressure.

Modulus of rupture is not an important property requirement of incinerator refractories. It is a measure of strength. If the modulus of rupture is as high as specified, damage will not be expected in shipping.

The workability index of plastic refractories is a measure of the plastic deformation of a molded test specimen when subjected to impacts. It serves as a measure of the facility with which plastic material can be rammed or pounded into place in a furnace.

The refractoriness of a mortar is determined by heating a pier of brick laid up with the mortar to establish whether the prescribed heat treatment causes the mortar to flow out of the joints.

The ASTM has no specifications for silicon carbide refractories for incinerator use but Committee C-8 has assigned to its subcommittee on specification the task of preparing one. As previously mentioned, they are used in some large incinerators near the grate line.

Alternatives to Cooling Excess Air

A serious disadvantage to the use of excess air for flame cooling is that the increased volume of exhaust gases demands larger dust collection equipment. One alternative has been introduced recently in the form of a completely water-cooled furnace. This is similar in principle but entirely different in form from the water-cooled cast-iron incinerators common in Europe some years ago. Thus, a trend which began much earlier in large boiler furnace construction leading toward virtual elimination of refractories has been introduced to American incinerators.

Acknowledgments:

The authors acknowledge the comments which they obtained from a number of experienced engineers skilled in the operation and design of large incinerators and from refractories experts who reviewed the manuscript.

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Technical Writing Need Not Be Dull

THOSE OF US who are convinced of the need for livelier, less strait-laced prose in the technical literature can rejoice at the appearance of the textbook, "Analysis of Straight-Line Data," by Forman S. Acton, associate professor of electrical engineering, Princeton University. The technical worth of this book is ably appraised by John Mandel on page 66 of this BULLETIN. Technical worth aside, we were delighted with its literary quality. Mr. Mandel states that the informality of style is generally refreshing but occasionally the author lapses into flippancy. We couldn't let it go at that. We feel that a sprightly text on such an unlikely subject as statistics is an accomplishment of the first magnitude. It is obvious that Prof. Acton took great pains with his manuscript. He was not afraid to let his wit show. The result is a nimble volume sprinkled with well chosen touches of disrespect that the technical world needs occasionally to deliver it from the evil of taking itself too seriously.

At the beginning of the section titled "Components of Variance from Finite Error Population," for example, Prof. Acton writes:

"The algebra of these finite populations is messy. Fortunately a general pattern is visible to the initiated, so the detailed grinding out of an expected value for a Mean Square in the analysis of variance table can frequently be circumvented. Nevertheless, we know of no convenient illustration of the gruesome process and feel that a desirable completeness requires its inclusion at this point. Students may wish to peruse this section; men of faith or demonstrated ability will probably choose to skip it. We claim no elegance or particular conciseness in the exposition. We merely attempt to include enough of the steps to lead the timid and guide the wary."

Later on, there appears a refreshing note of candor:

"Analysis of a problem lying between these models is beyond both the scope of this manual and the ability of its author."

He personifies statistical data:

"One of the first problems is to decide whether our data do indeed degenerate happily along a line or do they have this γ quantity cluttering up most of the Between Squares and all of the confidence limits?"

He philosophizes:

"Although it is far from certain that our Creator cast this universe in a linear mold, it is quite apparent that we strive continually to force it back into one. Our arithmetic becomes so much easier! . . . But to hope for linearity in all our experiments is sheer folly, and statistical methods must be provided if they are to serve the world in which we live rather than some ivory tower wherein all lines are straight and fluctuations normal."

He does not hesitate to let the reader know when the author's position is shaky:

"What mean square yardstick shall we use to separate the statistical fluctuations from real physical symptoms? The duplicate suggestion of 110 has been rejected as probably unsound, and the interaction estimate of 983 is (hopefully) too large. In this example we have concluded that 983 is not too large, but the argument is a proof-by-denial (a favorite with mathematicians, inquisitors, and missionaries)."

And again:

". . . Intuitively, I think not, but I cannot prove it and so my intuition may merely represent wishful thinking."

A few thoughts on the subject of conformity:

"When we are faced with a set of data, together with a theory about how they should behave, we often find one or two stragglers who have wandered off from the rest. . . . Whatever our method of throwing the rascals out, it ultimately rests on an assumption that the rascals belong to a family different from the rest of the data. . . . To construct a rejection scheme we rely on a guilt-by-lack-of-association principle (perhaps we should call it lack of conformity). We estimate the dispersion of the principal underlying population and then test the suspected datum for abnormal deviations. (Statisticians tend to be more tolerant than physical scientists, who in turn are more lenient than politicians.)"

It should not be inferred that these few examples represent the tone of the entire book. On the contrary, when Prof. Acton wants to get technical and serious, he does so, and that is most of the time. But there are just enough moments of relaxation to refresh the reader for the heavy going ahead. We feel that Prof. Acton has given technical communications a sorely needed push in the right direction.

Advertising—Its Importance to the Technical Man

ADVERTISING HAS come a long way from its humble beginnings. At one time, the advertiser simply recited his name and address and left it to the prospective customer to guess the product or service offered. Then, one day, a bold revolutionist not only identified himself, but also listed his products. He even dared to quote prices and shipping terms. Advertising today, particularly industrial advertising, has moved far beyond this concept.

There is clearly a place for industrial advertising in the reading of all who wish to keep abreast of their field. Addressed to the technical man, it supplies a wealth of current information; in essence, it reflects the day-to-day progress of science and technology. New developments often appear in advertisements before they are described in slower-moving forms of communication. Present-day refinements of many products—products admittedly ancient in concept—might escape the technologist if it were not for the easily digested information in advertisements.

For the busy scientist or engineer, advertising provides a relatively quick way to learn of new products, new applications for old products, unusual case histories, fresh information on the physical properties of materials, current data on processes and services, and a host of other hard facts that can help him to solve current problems and stimulate thinking for things yet to come.

It is regrettable that the exaggerated claims, appeals to emotion, and other less palatable techniques of the "hidden persuaders" of some consumer advertising must inevitably taint, by association, the image of industrial advertising. Industrial advertisers have long since recognized the importance of factual presentation. They present their facts with a minimum of superlatives. Most industrial advertisements are well written in clear English designed to bridge with minimum effort the gap between buyer and seller. Illustrations are more than decorative—they inform. Skillful layout gives the message clarity and unity.

Apart from its primary mission, industrial advertising has one very important, but often overlooked, side benefit. Advertising in the journals of professional, technical, and scientific organizations makes possible, in many instances, the economic existence of these journals. Thus advertising support has nurtured the dissemination of basic scientific knowledge, apart from the immediately useful information available in the advertisements themselves.

Advertising is an important link in the chain of events leading from the initial discovery of basic knowledge through development, to production, and back to the demand for more basic knowledge. Within ASTM, for example, new methods of test have created a need for new and better instruments which, when developed, produced, sold, and used, have opened the way to more reliable data, stimulating, in turn, a desire and need for more refined information. Through this closed circle of events the instrument industry keeps pace with technology as a whole.

Following is a directory of companies that have advertised in the ASTM BULLETIN during the recent past. It is hoped that this directory will be helpful to both readers and advertisers.

Directory of Recent ASTM Bulletin Advertisers

Aero Research Instrument Co., Inc.

315 N. Aberdeen St., Chicago 7, Ill.

Ceramic-insulated thermocouple wire and conductors, AerOpak thermocouples, airspeed heads, thermocouple reference junctions, thermistor and pressure probes, AerOpak heaters, temperature and pressure sensing, consultation and testing.

Alpha Molykote Corp.

65 Harvard Ave., Stamford, Conn.

Friction wear testers. Molykote lubricants.

American Instrument Co., Inc.

8030 Georgia Ave., Silver Spring, Md.

Scientific instruments: chemical, biochemical, constant-temperature, hygrometry, superpressure, regulating devices, and materials testing devices.

H. Reeve Angel & Co., Inc.

9 Bridewell Place, Clifton, N. J.

Whatman and Reeve Angel filter papers for filtration of liquids on laboratory or production scale. Also Eastern sales representatives for the National Appliance Co., manufacturers of controlled environment apparatus.

Arcweld Manufacturing Co.

Liberty St. Extension, Grove City, Pa.

Creep and stress rupture machines, elevated temperature tensile equipment, extensometers, vacuum retorts, hot grips, asphalt testers, textile tensile tester, and related instrumentation.

Arenberg Ultrasonic Laboratory, Inc.

94 Green St., Jamaica Plain (Boston), Mass.

Ultrasonic test equipment, ultrasonic delay lines, consulting and development.

Atlas Electric Devices Co.

4114 N. Ravenswood Ave., Chicago 13, Ill.

Accelerated testing equipment for determining end-use performance characteristics. Weather-Ometer, Fade-Ometer, Launder-Ometer, Accelerotor, random tumble pilling tester, scorch tester.

Baldwin-Lima-Hamilton Corp.

42 Fourth Ave., Waltham 54, Mass.

Complete line of static and dynamic testing machines and accessories: tension, compression, and universal testers; B-L-H Sonntag and I-V fatigue testers; impact testers; offset yield strength printers; recorders; grips; etc.

B & H Instrument Co., Inc.

3479 W. Vickers Blvd., Ft. Worth 7, Tex.

Milli-V-meters for direct digital reading of parabolic or logarithmic functions generated by strain gages, thermocouples, thermistors, or variable-frequency systems.

Branson Instruments, Inc.

37 Brown House Road, Stamford, Conn.

Ultrasonic equipment including pulse echo and transmission flaw detectors for metals, ceramics, and other solids; portable and automatic gages for measuring thickness from one side; cleaning and decontamination equipment.

Nuclear Systems, A Division of the Budd Company

2450 Hunting Park Ave., Philadelphia 32, Pa.

Gamma radiography equipment, irradiation devices and facilities, source material encapsulation, and contract research in the following areas: density thickness gaging, radiation equipment and service.

Buehler Ltd.

2120 Greenwood St., Evanston, Ill.

Metallurgical laboratory apparatus including cut-off machines, power grinders, hand grinders, belt surfacers, disk grinders, specimen mount presses, polishing

(*Continued on next page*)

machines, electro-polisher, polishing cloths, and abrasives.

Burrell Corp.

2223 Fifth Ave., Pittsburgh 19, Pa.

Complete line of scientific instruments and laboratory supplies.

E. J. Cady & Co.

630 N. Harlem Ave., River Forest, Ill.

Micrometers, basis weight scales, and bursting strength testers.

Cannon Instrument Co.

P. O. Box 812, State College, Pa.

Viscometers, viscosity standards, and constant temperature baths.

Central Scientific Co.

1700 Irving Park Rd., Chicago 13, Ill.

Laboratory apparatus, chemicals, and instruments specific to ASTM: DuNouy tensiometers, cement expansion test autoclave and molds, entrained air indicator for fresh concrete mixtures, moisture humidity apparatus for concrete block, etc.

Cosa Corp.

Chrysler Building, 405 Lexington Ave., New York 17, N. Y.

Schenck: Electro dynamic balancing machines, fatigue testing machines, dynamometers.

Custom Scientific Instruments, Inc.

541 Devon St., Kearny, N. J.

Physical testers for the adhesive, chemical cement, insulation, metal, paper, plastics, rubber, and textile fields. Custom built testing instruments of all types for individual and general needs. Catalog upon request.

Delta Chemical Works, Inc.

23 W. 60th St., New York 23, N. Y.

Chemicals, compounds, pharmaceuticals, metals.

Eastman Kodak Co.

343 State St., Rochester 4, N. Y.

The Eastman Kodak Co. manufactures photographic materials, X-ray film and equipment, man-made fibers, plastics, industrial and organic chemicals, vitamin concentrates, and monoglycerides.

Eberbach Corp.

Ann Arbor, Mich.

Manufacturers of electro-analysis and mercury cathode apparatus, laboratory shakers and stirrers. Also make water bath shakers, mercurial barometers, cathetometers, manometers, mercury stills, and Waring blender accessories.

George D. Ellis & Sons, Inc.

American & Luzerne Sts., Philadelphia 40, Pa.

Seamless tin cans.

Fisher Scientific Co.

107 Fisher Building, Pittsburgh 19, Pa.

Laboratory supplies, instruments, apparatus, reagent chemicals, laboratory furniture, and petroleum testing equipment.

Forney's Inc., Tester Div.

P. O. Box 310, New Castle, Pa.

Complete line of compression and flexure testing machines for concrete and concrete products: cylinders, cubes, blocks, beams, pipe, and tile. Also a complete line of collateral apparatus and supplies.

The Gaertner Scientific Corp.

1215 Wrightwood Ave., Chicago 14, Ill.

Dilatation interferometer, quartz tube dilatometer, optical extensometers, toolmakers' microscopes, optical and instrument benches, spherometers, spectrometers, measuring microscopes, viscometer, spectroscopes, monochromators, cathetometers, ellipsometer, photoelasticity polariscope, refractometer, interferometers, autocollimators, chronographs and comparators.

General Radio Co.

West Concord, Mass.

Complete line of electrical and electronic precise measuring instruments, including capacitance, impedance, oscillators, bridges, etc.

Gilson Screen Co.

Malinta, Ohio

Gilson testing screens and accessories for test sizing. Gilson Sample splitter.

Graphic Systems

55 W. 42nd St., New York 36, N. Y.

Boardmaster visual control boards for quality control, laboratory scheduling.

The Emil Greiner Co.

20 N. Moore St., New York 13, N. Y.

Laboratory Supplies. Catalog lists over 90 pages of petroleum equipment, special test equipment, glassware, and thermometers. These can be made to order according to ASTM specifications.

Gries Industries, Inc., Testing Machines Div.

New Rochelle 2, N. Y.

Complete line of hardness testing machines.

Harshaw Scientific Div. of The Harshaw Chemical Co.

1945 E. 97th St., Cleveland, Ohio

A complete line of laboratory instruments, apparatus, furniture, and chemicals.

H-B Instrument Co.

American & Bristol Sts., Philadelphia 40, Pa.

ASTM engraved stem thermometers and hydrometers, laboratory thermometers, hermetically sealed mercury plunger relays, mercury-in-glass temperature controls, midget industrial thermometers, etc.

High Voltage Engineering Corp.

Burlington, Mass.

Supervoltage (1 to 10 million volts) X-ray generators: portable model JR up to 5 in. of steel; model AF up to 10 in. of steel; Linac, above 5 mev, up to 20 in. of steel. Van de Graaff and microwave linear accelerators.

Carl Hirschmann Co., Inc., Amsler Testing Machine Div.

30 Park Ave., Manhasset, N. Y.

Amsler material testing machines, fatigue testing machines, maximum 250,000 lb; structural test plants, static and fatigue; creep and relaxation testers; Chevenard micro-tester; special purpose testing plants; Swiss precision machine tools.

The Hoggson & Pettis Mfg. Co.

141 Brewery St., New Haven 7, Conn.

Laboratory dies and molds for all types of testing made to ASTM Designations.

Hunter Spring Co.

20 Spring Ave., Lansdale, Pa.

Tensile testers, wire fatigue testers, compression and tension gages (hand-held).

Instron Engineering Corp.

2500 Washington St., Canton, Mass.

Universal testing instruments. Complete line of precision materials testing instruments designed for the studies of a wide variety of materials from the finest single fiber to superalloys and ceramics.

Instruments for Research and Industry

Cheltenham, Pa.

Acrylic safety shields, water-flow automatic switch boxes, temperature controls.

Instrument Society of America

313 Sixth Ave., Pittsburgh 22, Pa.

Nonprofit technical society providing as one of its many services English translations of leading Soviet technical journals at nominal subscription rates.

Jarrell-Ash Co.

26 Farwell St., Newtonville 60, Mass.

Spectrographs, microphotometers, chromatographs, photoprocessors, spectrochemical excitation units, spectrometers and monochromators.

Kimble Glass Co., a subsidiary of Owens-Illinois Glass Co.

P. O. Box 1035, Toledo 1, Ohio

Glass tubing, rod; medical, technical, scientific glassware; glass laboratory apparatus and laboratory glassware; vials, ampuls, syringe cartridges, etc.; glass block; Thinlite and Toplite glass block curtain wall and skylight assemblies.

Klett Manufacturing Co.

179 E. 87th St., New York 28, N. Y.

Colorimeters, fluorimeters, nephelometers, glass color standards, glass cells.

Koehler Instrument Co. Inc.

168-56 Douglas Ave., Jamaica 33, N. Y.

Petroleum and paint testing instruments, polariscope tubes, and special apparatus to individual specifications.

Labline Inc.

3080 W. Grand Ave., Chicago 22, Ill.

Laboratory apparatus, instruments and equipment for chemical, petrochemical, physical, petroleum, and industrial materials testing.

Laclede Steel Co.

Arcade Building, St. Louis, Mo.

Steel for construction and industry including carbon bars and small shapes, reinforcing steel, wire and welded wire fabric for reinforcement. Complete line of highway construction steel products, steel joists, accessories.

Marshall Products Co.

270 W. Lane Ave., Columbus 2, Ohio

High-temperature furnaces — tubular furnaces and control panels.

Mettler Instrument Corp.

P. O. Box 242, Princeton-Hightstown Road, Hightstown, N. J.

Analytical balances and precision scales with accuracies to ±0.002 mg and capacities to 12,000 g, and recording and remote control units. Automatic filling and sorting balances. Automatic electronic piece counters.

Micro Balancing, Inc.

191 Herricks Road, Garden City Park, L. I., N. Y.

Dynamic balancing machines—various models for precision balancing of rotating parts. Photoelectric street light control (Lumatrol), turns lights off and on by intensity of daylight.

Minneapolis-Honeywell—Heiland Div.

5200 E. Evans Ave., Denver 22, Colo.

Oscillographs and data recording instruments including Visicorder recording oscillograph.

Morehouse Machine Co.

1742 Sixth Ave., York, Pa.

Proving rings and force measuring instruments to National Bureau of Standards and ASTM specifications for calibrating testing machines and load cells.

Tinius Olsen Testing Machine Co.

Easton Road, Willow Grove, Pa.

Testing machines, tools, and instruments for compression, hardness, impact, torsion, and universal machines of all types; also a complete line of special testing machines.

Ozone Research & Equipment Corp.

3840 N. 40th Ave., Phoenix, Ariz.

Automatically controlled ozone test chambers and accessory items, automatic ozone control systems, ozone recording instrumentation, ozone generators, ozone testing service, ozone research and development, custom ozone equipment.

Parr Instrument Co.

211 53d St., Moline, Ill.

Bomb calorimeters for testing solid and liquid fuels. Oxygen and sodium peroxide bombs and accessories. Bombs, autoclaves, and miscellaneous laboratory apparatus for chemical reactions at elevated temperatures and pressures.

B. F. Perkins & Sons, Inc., Tester Div.

P. O. Box 388, Holyoke, Mass.

Burst testers (Mullen) for paper, paperboard, fabrics, leather, plastics; hydrostatic pressure testers for waterproofed fabrics; bond testers for polyethylene coatings.

Picker X-Ray Corp.

25 S. Broadway, White Plains, N. Y.

Industrial X-ray and gamma-ray equipment, film, darkroom equipment, and magnetic particle inspection equipment.

Plas-Tech Equipment Corp.

4 Mercer Road, Natick, Mass.

Manufacturers of "Plastechon" high-speed universal testers (speeds up to 8000 in. per min), and "Plasti-Dart" instrumented and uninstrumented dart drop testers; specialists in plastics research, development, and testing.

Precision Thermometer and Instrument Co.

1434 Brandywine St., Philadelphia 30, Pa.

Laboratory thermometers, industrial thermometers, mercury-in-glass thermostats, specific gravity controllers, barometers.

Radio Corporation of America

Front and Cooper Sts., Camden, N. J.

Electron microscope, X-ray diffraction and spectroscopy equipment, table-top and console type generators, and a full line of cameras, attachments, and accessories.

Research Appliance Co.

Box 307, Allison Park, Pa.

Hydraulic fluid test stand, cutting fluid test stand, chemical feed pumps, demulsibility test, spontaneous ignition test, air samplers, hydrogen sulfide samplers.

Riehle Testing Machines Div. American Machine and Metals, Inc.

East Moline, Ill.

Manufacture and sell physical test machines.

E. H. Sargent & Co.

4647 W. Foster Ave., Chicago 30, Ill.

Manufacturers and distributors of scientific laboratory instruments, apparatus, supplies, and chemicals since 1852—serving science for over 107 years.

Scott Testers Inc.

120 Blackstone St., Providence, R. I.

Tensile testers, viscometers, and complete line of physical testing instruments.

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway, Jamaica 35, N. Y.

Shore durometers for testing the hardness of rubber and rubber-like materials. Shore scleroscopes for testing the hardness of metal and other materials.

Sieburg Industries, Inc.

Danbury Industrial Park, Danbury, Conn.

Tensilkut high-speed contour milling equipment for the rapid and accurate machining of physical test specimens from film, foil, sheet, or plate, metals and nonmetallics.

SMS Instrument Co.

P. O. Box 24, Rensselaer, N. Y.

Sample Cutting Press "NAEF." Dies with expulsion for ASTM Methods D 39, D 378, D 380, D 412, D 624, D 1004, D 1117, D 1175, D 1230, D 1295, and D 1375.

Soiltest, Inc.

4711 W. North Ave., Chicago 39, Ill.

Manufacturers and distributors of engineering test apparatus for soils, concrete, and bituminous materials, including field and laboratory devices, drilling rigs, and general laboratory supplies.

Syntron Co.

444 Lexington Ave., Homer City, Pa.

Syntron vibrating test sieve shakers for quick, accurate sieve analysis of bulk materials. Syntron vibratory lapping-polishing machines provide easy, mechanical lapping and polishing of metallurgical specimens.

Tatnall Measuring Systems Co., Subsidiary of the Budd Co.

P. O. Box 245, Phoenixville, Pa.

PhotoStress, strain gages (bonded metal film type), and instrumentation; creep testing machines, fatigue testing machines, and universal testing machines. PhotoStress and strain gage transducers.

Technicon Controls Inc.

Chauncey, N. Y.

Automatic chemical analyzers with capacity of 60 analyses per hour.

Testing Machines, Inc.

72 Jericho Turnpike, Mineola, L. I., N. Y.

Precision physical testing machines of all types for all industries including complete repair, along with calibrating and customer design service.

Thermo Electric Mfg. Co.

472 Huff St., Dubuque, Iowa

Laboratory and industrial furnaces, temperature controllers, hot plates, flask heater, magnetic stirring hot plate, and other related items.

Arthur H. Thomas Co.

Vine Street at Third (P. O. Box 779), Philadelphia 5, Pa.

21,000 items of laboratory apparatus and reagents for chemistry and biology, as listed in our catalog and supplements, regularly carried in stock for immediate shipment from our Philadelphia warehouse.

Thwing-Albert Instrument Co.

Penn St. and Pulaski Ave., Philadelphia 44, Pa.

Electrical and mechanical measuring and testing instruments. Temperatures, all ranges. Physical properties of paper, plastics, textiles, and light metals. Built to meet ASTM specifications.

(*Continued on next page*)

Advertising

Unit Process Assemblies, Inc.

61 E. 4th St., New York 3, N. Y.

Periodic-reverse plating units for electroplating and alkaline derusting and descaling. Dermitron nondestructive coating thickness tester for the measurement of metallic and nonmetallic coatings.

Unitron Instrument Div. of United Scientific Co.

204–6 Milk St., Boston 9, Mass.

Microscopes for research, industry, and education: laboratory, biological, metallurgical, stereoscopic, phase, and polarizing models; metallographs; photomicrographic attachments; micrometer and grain size measuring eyepieces; camera lucidas; vacuum heating stages. Astronomical telescopes.

Wabash Metal Products Co., Inc.

Box 305, 1569 Morris, Wabash, Ind.

Manufacturer of Wabash hydraulic laboratory presses, small stampings, metal indexing tabs.

Weksler Instruments Corp.

195 E. Merrick Rd., Freeport, L. I., N. Y.

ASTM thermometers and hydrometers; indicating recording instruments for temperature; pressure, humidity; industrial glass thermometers; hydrometers, psychrometers, and general testing thermometers—domestic, photographic, industrial.

Will Corporation and Subsidiaries

Rochester 3, N. Y.; Atlanta 1, Ga; Baltimore 24, Md.; Buffalo 5, N. Y.; New York 52, N. Y.; So. Charleston 3, W. Va.

Laboratory apparatus, furniture, instruments, and chemicals; products of 900 manufacturers stocked and serviced, including Buehler metallographic equipment, AO and B & L metallurgical instruments, Leco and Lindberg combustion apparatus. Free 1008-page catalog.

Wilson Mechanical Instrument Div, American Chain and Cable Co., Inc.

230-C Park Ave.. New York 17, N. Y.

"Rockwell" hardness testers, "Rockwell" superficial hardness testers, "Rockwell" hardness TwinTesters, diamond "Brale" penetrators, Tukon microhardness testers, and Campbell nibblers.

14th Exhibit of Scientific, Testing, and Laboratory Apparatus

To be held in conjunction with the 63rd ASTM Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 26–July 1, 1960.

PRODUCERS AND distributors of apparatus, instruments, and supplies for testing, research, quality-control inspection, and related work are invited to take this opportunity to display the newest developments in their products to an interested audience.

This popular biennial event draws leaders from science and engineering who are interested in the latest in instrumentation and apparatus. These men specify, buy, and use scientific equipment and laboratory supplies. Attendance at the 62nd Annual Meeting, in the same location, was well over 3000.

For prospectus and application form, write: **Mr. F. F. Van Atta, Assistant Secretary, ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.**

Attendants at the Exhibit held in conjunction with the 1956 West Coast Meeting.

Random Samples. . .

FROM THE CURRENT MATERIALS NEWS

Polar Research

CAMP TUTO, fourteen miles from Thule, Greenland, is the world's first permanent polar research laboratory. The buildings of Thule Air Base and the U. S. Army Polar Research and Development Center, the most northern of all fixed settlements, are feats of modern engineering.

Until 1954, limited polar research was carried on by independent agencies such as the Air Force, the American Geographical Society, and the Army Transportation Corps, using various military installations in the Far North begun during World War II. Thule Air Base was built for the Strategic Air Command during the Korean War. Moderate research in arctic construction followed under the Army Corps of Engineers; in 1958, another reorganization created the Army Polar Research and Development Center, whose program is directed by civilian scientists connected with four different research agencies of the Corps of Engineers.

At first, only a few individual research projects were carried out in the immediate vicinity of Thule, which is located in northwest Greenland 930 miles from the North Pole. Today, over thirty projects, ranging from basic research in glaciology to developments in practical arctic construction, are conducted from four separate camps—three of them on the icecap. They stretch from Camp Tuto on the land area to Camp Fistclench, 220 miles east of Tuto on the central icecap. The major part of the program is planned for the summer, which lasts from the middle of May to September (even then, C-rations and heavy arctic clothing are in common use!).

Greenland is about 1600 miles long and at most 650 miles wide. Nine-tenths of it is permanently covered with snow and ice. Allegedly, Greenland was named in the 10th century by Eric the Red, a Norseman who, having explored the southwest coast, wanted to establish a colony there and thought such a name would attract his countrymen.

At Thule, temperatures down to −75 F and winds of 100 mph are common in winter, although summer days bring more pleasant temperatures, sometimes in the 50's. Snowfall averages about three feet a year, but above an elevation of a few thousand feet it never melts, so that a load of hundreds of millions of tons is added to the icecap annually. The "icecap," which is almost two miles thick at its crest, is mostly ice and névé—persistent, constantly accumulating, hardened snow. Ice cores drilled down to depths of 1345 ft have been extracted for analysis. Air bubbles trapped in the cores are expected to reveal atmospheric content as far back as the 11th century, and will perhaps enable scientists to determine the degree of air pollution since then. Although no conclusions are yet drawn, one interesting finding is the total absence of preserved bacteria.

As snow accumulates on the icecap, the snow beneath the surface increases in density, and the mass as a whole yields in a slow, plastic movement. It flows between the seacoast mountains as glaciers, which are filled with dangerous cracks and crevasses—sometimes 50 ft wide and 200 ft deep—often closed over by thin snow bridges and thus undetectable by eye. Crevasses are a hazard at the icecap edge and for some distance out on the icecap itself. The perimeter of land is permanently frozen up to depths of 1000 ft; during the summer, however, the surface thaws and surface soils often turn to mud. Building foundations require special design and construction to prevent thawing of the permafrost and settling of the buildings.

A major accomplishment of the research program has been in detecting hidden crevasses. In one method, portable electronic instruments resembling mine detectors are used. Another method employs a radiometer, which measures the difference in thermal radiation of crevasse roofs and the adjacent solid snow. Another research project is concerned with a phenomenon of the icecap known as "whiteout," a condition of poor visibility caused by the suspension of minute, supercooled water droplets in the air. So far, cloud seeding is considered the most promising method of dispersing whiteout fogs to permit aircraft to land.

Under the proper conditions, the snow on the icecap can be used for construction. Hard-packed snow, for example, has been used as surfacing for a runway. And at Camp Fistclench in 1957, an undersnow camp was completed to support 150 persons; besides billets, facilities included kitchen, dining hall, hot and cold water systems, lavatories, showers, laundry, a 150-kw power plant, and spaces for storage, a dispensary, a maintenance shop, and radio communications. The common type of roofing for such a undersnow structure consists of snow-covered, metal-arch forms; the 1958 program, however, included the construction of a short section of roof with beams precast in snow. The life expectancy of such a structure is estimated at five years.

Industrial Bulletin,
Arthur D. Little Co.,
February, 1959.

Test Cuts Refinery Costs

WITH THE ABILITY to measure as little as one-millionth of an inch of corrosion in a matter of hours, a small, portable meter is being used at Union Oil Co.'s Los Angeles Refinery to reduce depreciation costs.

Union Oil engineers are using the meter to determine corrosion inhibitor requirements in the diethanol amine (DEA) cycling stream, a neutralizing process for refinery end products.

The DEA process constitutes one of the most severe corrosion problems in the refinery. Before an effective inhibitor was found, tubes within the DEA reboiler would fail in 1 to 3 months. Today, through the addition of an inhibitor, tube life has been multiplied five to ten times.

With a corrosion meter "probe" in constant contact with the corrosive liquids in the DEA reboiler, operating personnel measure corrosion regularly. When any corrosion is detected, the inhibitor is added. Used in this manner, the instrument not only provides corrosion protection at all times, but eliminates costly over-addition of the inhibitor.

The meter, manufactured by the Crest Instrument Division of Magna Products, Inc., measures corrosion by determining the ratio of the resistances of two metal specimens, one exposed to the corrosive environment, the other protected by a plastic or glass coating. As the exposed strip is attacked by chemicals within the DEA reboiler, its electrical resistance increases while that of the protected specimen remains unchanged. Since both pieces of metal are contained within the same probe structure, temperature fluctuations do not affect their resistance ratio.

PROFESSIONAL CARDS

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130 Cedar Street New York 6, N. Y.

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Chemical & Metallurgical Analysts for
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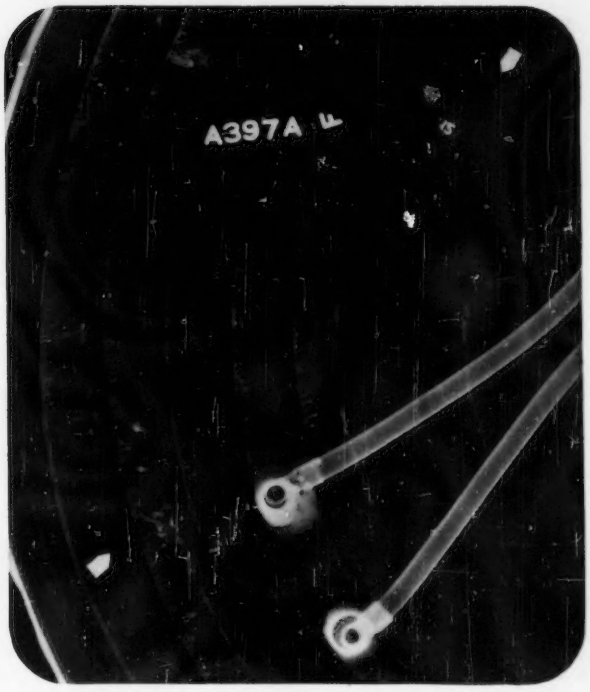
A Cherry-Burrell milk-cooling tank with heat exchanger welded to the bottom.



Radiograph showing welding had flashed, leaving splattered metal spurs.

The tank had to be "Tops" —*Radiography pointed a way*

Milk handling and storage equipment has the most rigid health and sanitary requirements. The high quality and safety of milk must be protected. So, when this Cherry-Burrell farm milk cooling tank was developed, every precaution was taken to strive for perfection.

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Copies of these books are not available through ASTM; all inquiries concerning them should be addressed to the publisher.

Analysis of Straight-Line Data

Forman S. Acton, John Wiley & Sons, Inc., New York, N. Y., 1959, 267 pp., Illus., $9

THE LAST few years have brought a spate of general textbooks on statistical methods, many of which are intended for self-study. The user of statistical techniques needs, in addition to this general information, more detailed treatments of special topics. The analysis of straight-line data is of sufficient interest in the physical sciences to be worthy of an unhurried treatment for the benefit of workers in this field.

Straight lines can be fitted by eye with considerable success. The introduction of sophisticated statistical methods in this field can only be justified if these methods result in a better understanding of the structure of errors affecting the data and in a realistic evaluation of the predicting power of a fitted straight line. This book rightfully draws attention to the importance of deciding upon a model before attempting an analysis of a set of data. A chapter is devoted to each of a number of important models, starting with the classical case (x known without error; variance of y constant) and some of its ramifications. There follows a discussion of the bivariate normal case, and a lengthy chapter dealing with situations in which both variables are subject to error. The remainder of the book deals with a variety of subjects, such as the detection of curvature, with a digression on orthogonal polynomials, transformations of scale, the rejection of data, and cumulative data. A number of useful tables are appended.

The book is written for the experimenter and must, therefore, be evaluated in terms of its usefulness to a person with little or no background in statistics. Unfortunately, the author seems to be unaware of the degree of maturity in statistical thinking and skill in computational techniques that a successful use of his book requires on the part of the reader. This is largely due to unsatisfactory organization of the statistical material. Thus, a chapter on the analysis of variance is introduced in the second half of the book long after considerable use has been made of its principles in previous chapters. The chapter dealing with regression in which both variables are subject to error does not entirely succeed in clarifying this difficult subject to the nonmathematical reader. Nevertheless, much of the book is written clearly and in a lively tone. The informality of style is generally refreshing but occasionally the author lapses into flippancy. This is especially true in the last few chapters which the author has cast in essay form, and concerning which he warns us not to expect too much. But much of the material in these chapters deserves a more thoughtful and detailed exposition. Thus, the last chapter, on cumulative data, consists of less than three pages, and does not come to grips with a situation that is a source of

(*Continued on next page*)

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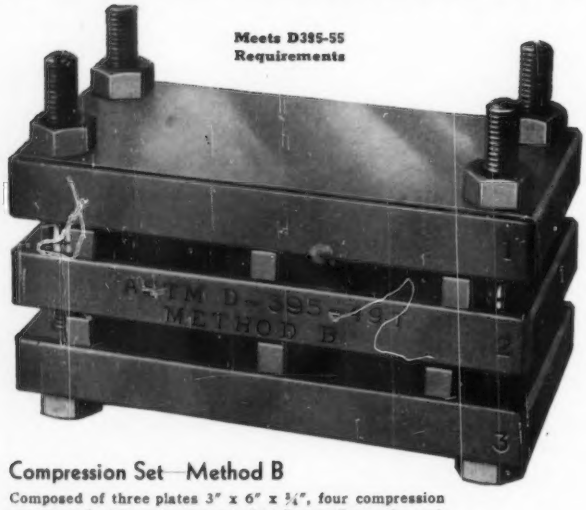

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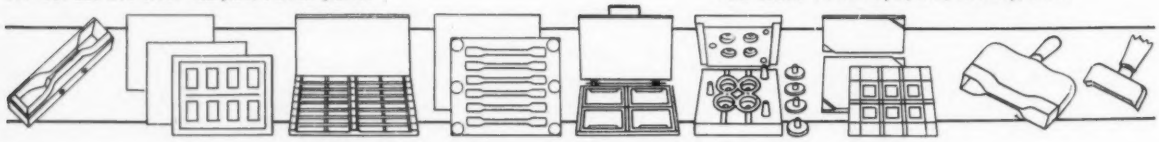

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many misconceptions, namely, the failure to recognize and understand the nature of cumulative errors. Similarly, the case, so frequent in the physical sciences, in which the error variance depends functionally on the magnitude of the measurement receives no more than a casual comment in reference to logarithmic plotting scales.

This reviewer would welcome a more consistent treatment of confidence intervals than is given in this book and in a number of others. This concept is introduced in all authoritative sources in connection with the bracketing of population parameters. If it is extended to the bracketing of random variables, such as "future" measurements, the reader should at least be informed about the extension. The successful use of statistical techniques in the physical sciences hinges upon a clear and unambiguous understanding of the basic statistical concepts and their range of application.

Two errors were noted: On page 135, the left-hand side of the equation preceding Eq. 10 should read θ rather than $\beta R\theta$, and in Eq. 10 the R in the second parentheses should read R^2.

JOHN MANDEL

Mechanical Properties of Non-Metallic Brittle Materials

Edited by W. H. Walton, Interscience Publishers, Inc., New York, and Butterworth's Scientific Publications, London, 1958, 492 pp., $12.75.

EXCEPT FOR METALS, fibers, and rubber-like materials, the scope of this book potentially includes virtually the full range of engineering solids, both natural and synthetic. The assortment is a heterogeneous lot varying so widely in properties compositions, and structures (macroscopic, microscopic, and molecular) as to make attempts at grouping difficult. It is this fact that has created an urgent need for just such a compilation of papers.

There are 27 separate papers or chapter titles and several times that number of authors and discussors. The solids include coal, concrete, gypsum, ceramics, and rocks. The chapters are grouped under four session headings: (1) strength properties, (2) elasticity and creep, (3) dynamic loading and fragmentation, and (4) response to the action of tools. The authors represent Great Britain's foremost authorities. As a first attempt at a synthesis in this neglected area the volume is felt to have accomplished its purposes admirably. It makes available in one place a summary of current information that is indispensible to present and future students and to users and producers of the materials covered. The treatments of concrete and coal are especially complete and helpful. The book is informational without being highly technical.

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(*Continued on page 78*)

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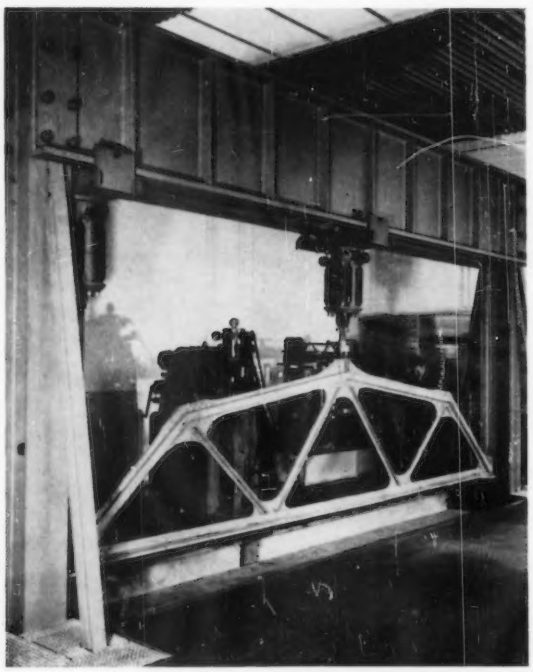

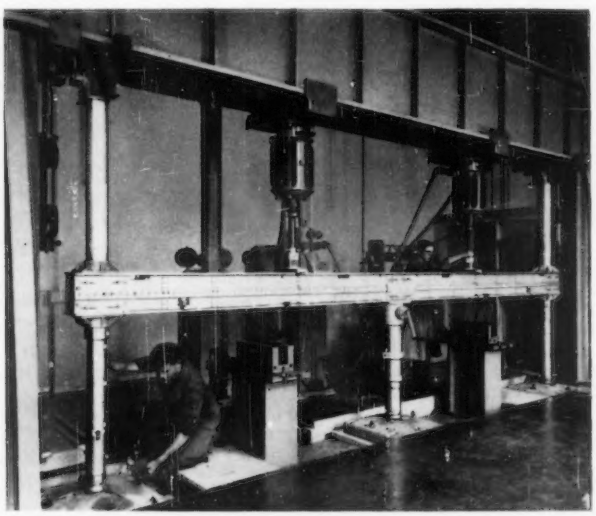

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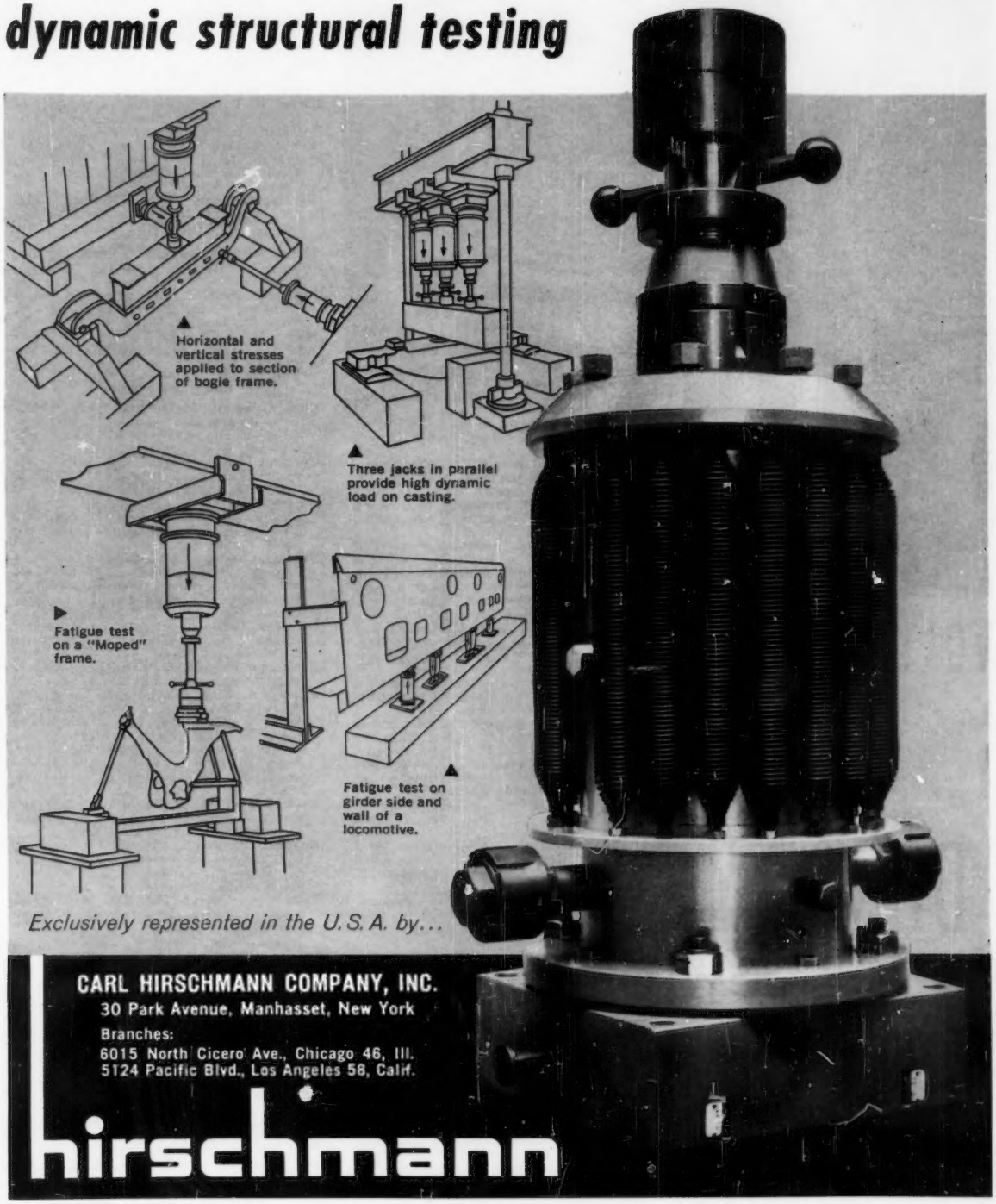
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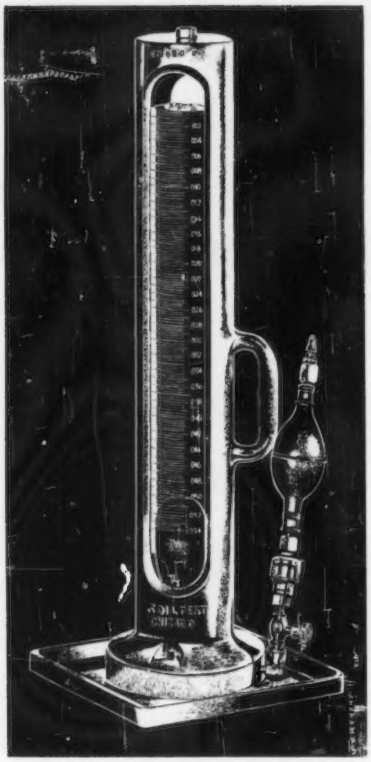

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Bassett, L. H., manager, Anaconda Aluminum Co., Box 1108, Terre Haute, Ind.

Bassler, R. B., superintendent, Plastics Dept., Gale Products Div., Outboard Marine Corp., Galesburg, Ill.

Baum, Martin A., research supervisor, Marathon Div., American Can Co., Rothschild, Wis.

Collins, Tappan, manager, Research Div., Stran-Steel Corp., 735 N. First St., Terre Haute, Ind.

Davenport, Charles R., metallurgist, Phoenix Manufacturing Co., Div. of Union Tank Car Co., Box 1207, Joliet, Ill. For mail: 932 E. Eighth St., Lockport, Ill.

Dolch, George D., Jr., chief metallurgist, Thompson Ramo Wooldridge, Inc., 23555 Euclid Ave., Cleveland 17, Ohio.

Fenton, Walter M., 4808 Colfax Ave., S., Minneapolis 9, Minn.

Fritz, Ira T., manager, Control Lab., Sinclair Refining Co., 410 Sibley Blvd., Harvey, Ill.

Hess, Fred R., proportioning engineer, Goodell Engineering Associates, 1305 S. Mattis Ave., Champaign, Ill.

Hoffmann, Robert, president, Chain-Link Fence Corp., 4301 W. 69th St., Chicago 29, Ill.

Kwiatkowski, Bohdan, director, research and development, U. S. Sanitary Specialties Co., 1001 S. California Ave., Chicago 12, Ill.

Lee, Robert J., president, Robert J. Lee, Inc., 8600 W. 68th St., Bedford Park, Ill. For mail: Box 155, Argo, Ill.

McLaughlin, J. F., research engineer and associate professor of civil engineering, Purdue University, School of Civil Engineering, Lafayette, Ind.

Mills, Robert E., construction engineer, airfields, U. S. Army Corps of Engineers, Box 3055, Madison 4, Wis.

Novik, David, executive vice-president, Goodkind & O'Dea, Inc., 108 W. Lake St., Chicago 1, Ill.

Offer, Robert J., supervisor of development and testing, Walker Manufacturing Co., 1201 Michigan Blvd., Racine, Wis.

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Cook, D. J., Purolator Products, Inc., Wayne Div., 3927 Fourth St., Wayne, Mich.

Dow, Edward F., chief production engineer, The Electric Auto-Lite Co., Spark Plug Div., Box 231, Fostoria, Ohio.

Dryer, H. T., applications engineer, Applied Research Laboratories, Inc., 20200 W. Outer Dr., Dearborn 8, Mich.

Evans, Robert R., plant manager, Cronin Transit Mix, 1325 E. Atwater, Detroit 7, Mich., For mail: 7322 Standard Ave., Centerline, Mich.

Garmager, John H., supervisor, Metal Finishing, Electro-Mechanical Products Co., 32700 Ford Rd., Garden City, Mich.

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Maxson, Richard N., physicist, Glass Container Manufacturers Inst., 121 W. South St., Lansing, Mich. [A]*

Miller, H. Paul, chemist and general manager, Cadilloc, Inc., 300 Haynes St., Cadilloc, Mich.

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Bayley, Charles W., Jr., chemist, Borden Chemical Co., 103 Foster St., Peabody, Mass. For mail: Main St., Norwell, Mass.

Bradley, Charles F., materials and standards engineer, Westinghouse Electric Corp., 653 Page Blvd., Springfield 2, Mass. For mail: 233 Main St., Wilbraham, Mass.

Corcoran, James L., director of engineering, Crosby Valve and Gage Co., 43 Dendrick St., Wrentham, Mass.

Henderson, Wendell L., laboratory manager, Avon Sole Co., Box 785, Avon, Mass.

Kutsay, A. Umit, assistant chief engineer, Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass. For mail: 155 Concord Rd., Wayland, Mass.

Lord, Joseph, director, Research Laboratory Dept., Instrument Development Laboratories, Inc., 67 Mechanic St., Attleboro, Mass.

Ross, Robert W., technical service representative, Shawinigan Resins Corp., 644 Monsanto Ave., Springfield 1, Mass.

Ruggeiro, Virginia S., director of Laboratory Div., Bristol Research Associates, Inc., 471 Hope St., Bristol, R. I. For mail: 956 Hope St., Bristol, R. I.

Tsimekles, George Nicholas, mechanical design engineer, Eastern Air Devices, Central Ave., Dover, N. H. For mail: 1 Paul St., Somersworth, N. H.

Vitale, Joseph M., chief chemist, The Crescent Co., Inc., 20 Central Ave., Pawtucket, R. I.

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Baum, Richard T., partner, Jaros, Baum & Bolles, 730 Third Ave., New York 17, N. Y. For mail: 12 Helena Ave., White Plains, N. Y.

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Buckley, Robert E., technical service, product development, U. S. Borax and Chemical Corp., 50 Rockefeller Plaza, New York 20, N. Y.

Connell, Horton R., vice-president, Petroleum Specialties, Inc., 205 E. 42nd St., Rm. 1300, New York 17, N. Y.

Danziger, Glenn N., assistant chief chemist, Breinig Brothers, Inc., 95 Harrison St., Hoboken, N. J. [A]

Gagliano, Joseph A., marine engineer, Greole Petroleum Corp., Apartado 172, Maracaibo, Venezuela. For mail: 164 Ocean Ave., Lynbrook, N. Y.

Han, Haipo C. T., director, Division for Ministry of National Defense, Chinese Government Procurement and Services Mission, 149 Broadway, Rm. 1028, New York 6, N. Y.

Hart, Harold C., hydraulic engineer, Development and Resources Corp., 50 Broadway, 25th Floor, New York 4, N. Y.

Hartmann, Hans Rudolf, consulting engineer, Amsler Testing Machine Div., Carl Hirschmann Co., Inc., 30 Park Ave., Manhasset N. Y. For mail: 130 Jerusalem Ave., Hempstead, L. I., N. Y.

Hendry, David W., Metallurgical Laboratory, A. Schrader's Son Div., Scovill Manufacturing Co., 470 Vanderbilt Ave., Brooklyn 38, N. Y.

Herman, C. Richard, vice-president, research and development, Rubber Latex Company of America, 110 Delawanna Ave., Clifton, N. J.

Hess, Albert W., chief technical advisor, Aluminum Div., Olin Mathieson Chemical Corp., 400 Park Ave., New York 22, N. Y.

Holm, Warren M., technical director, Radium Chemical Co., Inc., 161 E. 42nd St., New York 17, N. Y.

Hunter, J. Stuart, research associate, Princeton University, Princeton, N. J. For mail: 1123 Stilford Ave., Plainfield, N. J.

Ingram, William T., adjunct professor, New York University, College of Engineering, University Heights 53, New York, N. Y. For mail: 20 Point Crescent, Whitestone 57, N. Y.

Norris, David P., development engineer, Union Carbide Plastics Co., Bound Brook, N. J. For mail: Woodlawn Ave., R. D. No. 5, Somerville, N. J. [A]

Oravec, Emil G., chief engineer, M B Electronics, Box 1825, New Haven 8, Conn.

Oskroba, Bruno E., purchasing agent, Beckley Perforating Co., 315 North Ave., Garwood, N. J.

Rose, Walter B., quality control engineer, Quality Assurance, Reeves Instrument Corp., Roosevelt Field, Garden City, L. I., N. Y. For mail: 225 Martin Dr., Syosset, L. I., N. Y.

Rudolf, Mitchell J., assistant director, Use-Tested Program, McCall Corp., 230 Park Ave., New York 17, N. Y.

Sawyer, Alfred W., partner, Hazen & Sawyer, 122 E. 42nd St., New York 17, N. Y.

Soderberg, Herman, electronics research, Maritime Chemical and Repair Corp., 421 Hamilton Ave., Brooklyn 32, N. Y.

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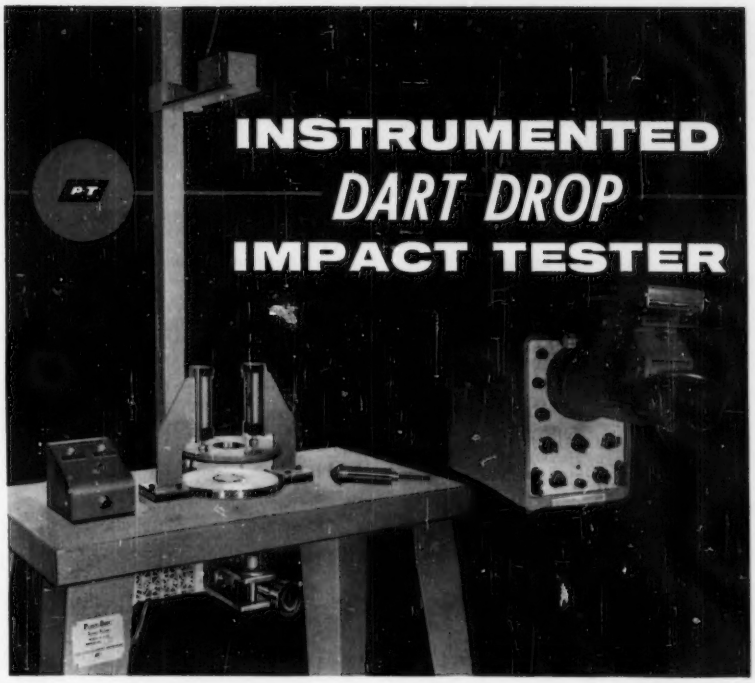
(*Continued on page 72*)



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Bennett, Frank W., metallurgical engineer, Union Carbide Chemicals Co., Technical Center 770-352, South Charleston, W. Va. For mail: 5623 MacCorkle Ave., South Charleston 3, W. Va. [A]

Evans, Ralph A., director, Research Laboratory, Link-Belt Co., 220 S. Belmont Ave., Indianapolis 6, Ind.

Favor, Ronald J., metallurgist, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio. [A]

Lundeen, Howard A., quality control manager, The Raymond Bag Co., Div. of Albemarle Paper Manufacturing Co., Enoch Dr., Middletown, Ohio.

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Gerhart, Clarence M., owner, Gerhart and Associates, 1314 Land Title Bldg., Philadelphia 10, Pa.

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Knupp, G. Gilbert, assistant metallurgical engineer, Bethlehem Steel Co., Inc., Bethlehem, Pa.

Risi, Le Roy, chief chemist, Shieldalloy Corp., Box 68, Newfield, N. J. For mail: 712 Broadway, Vineland, N. J.

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Caine, K. E., Jr., alloy steel junior technologist, U. S. Steel Corp., Applied Research Laboratory, Monroeville, Pa. [A]

Dyek, Norman P., development chemist, Curtiss Wright Corp., Curon Div., Quehanna, Pa.

Hunsicker, Harold Y., chief, Physical Metallurgy Div., Alcoa Research Laboratories, Freeport Rd., New Kensington, Pa. For mail: Box 772, New Kensington, Pa.

Porter, Lew F., research technologist, U. S. Steel Corp., Applied Research Laboratory, Monroeville, Pa.

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Lindmuir, Eric, specifications consultant, 1635 W. Monterosa St., Phoenix, Ariz.

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Muniz, Sotero, Jr., materials engineer, U. S. Forest Service, Engineering Div., Ogden, Utah. For mail: 417 34th St., Apt. 9, Ogden, Utah. [A]

Sage, Edward H., quality control manager, Frank R. Cook Co., 3850 Olive St., Denver 7, Colo. [A]

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Evans, Jay E., general manager, Law Engineering Testing Co., Box 1231, Birmingham 1, Ala.

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Collins, Jack E., president, Lancaster Ready Mix, Inc., 45315 Trevor, Lancaster, Calif. For mail: Box 748, Lancaster, Calif.

Goodman, Herman, civil engineer, 14420 Erwin St., Van Nuys, Calif.

Gorich, George M., assistant welding engineer, Long Beach Naval Shipyard, Long Beach 2, Calif. For mail: 2000 St. Louis Ave., Long Beach 6, Calif.

Rockwell, E. N., Jr., assistant chief chemist, Smith-Emery Co., 781 E. Washington Blvd., Los Angeles 20, Calif.

Sachs, Carrol C., professional chemical engineer, Admerco, Inc., 9938 Clybourn Ave., Sunland, Calif.

Spencer, Robert Selfridge, material research engineer, Varian Associates, 611 Hansen Way, Palo Alto, Calif. For mail: 169 Arbuelo Way, Los Altos, Calif.

White, Richard M., research chemist, Golden Bear Oil Co., Chemicals Div., Box 446, Oildale, Calif. For mail: 1900 Verde St., Bakersfield, Calif.

Young, Louis, structures engineer, Lockheed Aircraft Corp., Burbank, Calif. For mail: 2234 S. Spaulding Ave., Los Angeles 16, Calif.

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DeVerter, Paul L., consultant, Charles Martin and Co., 1215 Dumble St., Houston, Tex. For mail: Box 3011, Baytown, Tex.

Gaddy, James L., Jr., manager, test and inspection, Central Transformer Corp., Box 1753, Pine Bluff, Ark.

Olivier, Gaston P., foreign steel mills representative, 726 E. Creekside Dr., Houston 24, Tex.

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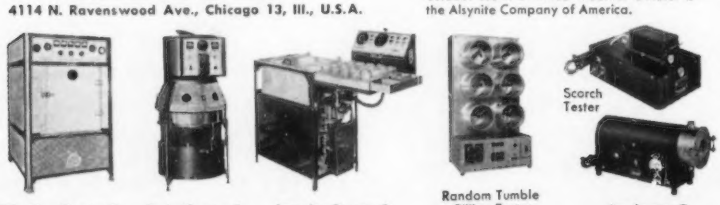

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McCullough, Charles Russell, professor of civil engineering, Civil Engineering Dept., and technical director, Highway Research Program, North Carolina State College, Raleigh, N. C.

Noell, William C., Jr., technical service engineer, Albemarle Paper Manufacturing Co., Technical Div., Richmond 17, Va. [A]

Sinclair, Walter P., consultant, 4007 Glenmore Ave., Baltimore 6, Md.

Turner, F. B., state property officer, North Carolina Department of Administration, Property Control and Construction Div., Box 1351, Raleigh, N. C.

Tyler, John C., Washington representative, Dyfoam Corp., 202 E. Cherry St., New Castle, Pa. For mail: 1475 Euclid St., N. W., Washington 9, D. C.

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Carson, Norman R., assistant chief engineer, R. W. Bech and Associates, 1500 Tower Bldg., Seattle 1, Wash.

Currier, Raymond A., in-charge, manufactured products, State of Oregon, Forest Products Research Center, Box 571, Corvallis, Ore. For mail: 714 S. 17th St., Corvallis, Ore.

Garcia Delgado, Luis G., acting street and drainage engineer, Federal Housing Administration, Puerto Rico Insuring Office, Box 8065, Santurce, Puerto Rico. For mail: Box 142, Roosevelt, Puerto Rico.

Harstad, Howard T., consulting engineer, Howard T. Harstad and Associates, 2512 Second Ave., Seattle 1, Wash.

Hoskins, Charlotta M., librarian, Experiment Station Library, Hawaiian Sugar Planters' Assn., Honolulu 14, Hawaii.

Krotz, Laird C., Spectrographic Laboratory, Titanium Metals Corporation of America, Box 2128, Henderson, Nev. For mail: 2516 Stanley, North Las Vegas, Nev.

Syme, John H., development director, Edward Hines Lumber Co., Box 360, Hood River, Ore.

Watson, J. Raymond, instructor, general engineering, University of Puerto Rico, College of Agriculture and Mechanic Arts, Mayaguez, Puerto Rico.

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Artus-Martinelli, Italo, staff engineer, D. Bonaldi & Co., Via Mercato 27, Crema (Cremona), Italy.

Bleakney, H. H., senior scientific officer, Canada Department of Mines and Technical Surveys, 568 Booth St., Ottawa, Ont., Canada.

Broehl, W., director of research, Klöckner Georgsmarienwerke, 1 Bessemerstr, Osnabrück, Germany.

Bryant, J. R., head, Metallurgical and Physical Laboratories, W. H. Allen Sons and Co., Ltd., Queen's Engineering Works, Bedford, England.

Canada, Department of National Defense, Departmental Library, 1082 C Bldg., National Defense Headquarters, Ottawa, Ont., Canada.

Child, H. C., research manager, Jessop-Saville Ltd., Research Dept., Whiston Grange, Moorgate, Rotherham, Yorks., England.

Cropper, John Wakefield, technical director, Mono (N. Z.), Ltd., Box 14-031, Panmure, Auckland, New Zealand.

Damerham, R. L. H., technical director, Durapipe and Fittings, Ltd., Winnock Rd., West Drayton, Middlesex, England.

Elder, J. Bruce, manager, Elder Electronics, 3200 Robert St., Burlington, Ont., Canada.

Goedecke, Friedrich, director, Stahl u. Rohrenwerk Reisholz GmbH, Henkelstrasse 248, Düsseldorf-Reisholz, Germany. For mail: Spohrstrasse 7, Düsseldorf-Benrath, Germany.

Goransson, Olof, metallurgical engineer, Rosenborgsgaten 18, Huskvarna, Sweden.

Instytut Metalurgii Zelaza, T. Malkiewicz, professor, Gliwice, Ul. K. Miarki 12, Poland.

Keith, G. T., president, Keith Consulting Engineers, Ltd., 1237 Albert St., Regina, Sask., Canada.

Kreitz, Karl, head, Experimental Station, Stahl u. Rohrenwerk Reisholz GmbH, Henkelstrasse 248, Düsseldorf, Reisholz, Germany. For mail: Bocklinstrasse 16, Düsseldorf, Germany.

Ladouceur, Jean-Louis, laboratory technician, Cartier, Cote & Piette, Mile Post 29, Shelter Bay, P. Q., Canada.

Matesco, Eduardo L., Industrial Chemistry Dept., Petroleo Brasiliero S. A., Landulfo Alves Refinery, C. Postal 1017, Salvador, Bahia, Brazil.

(*Continued on page 76*)

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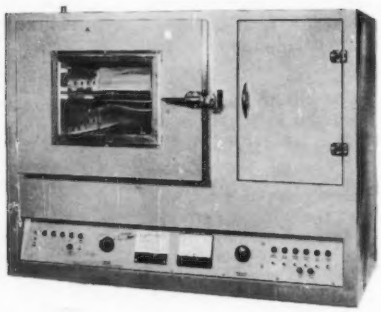

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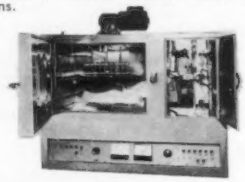

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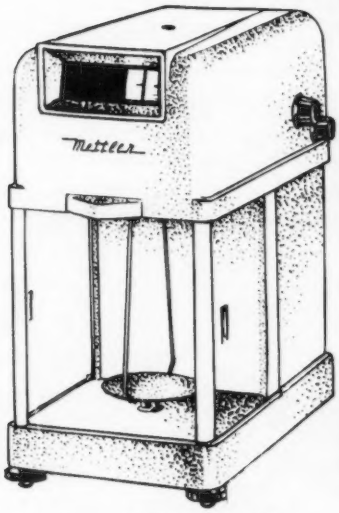

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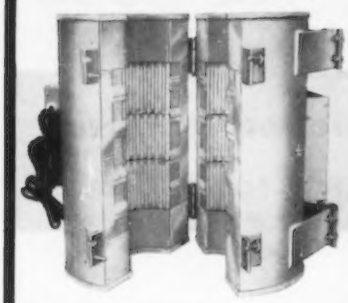
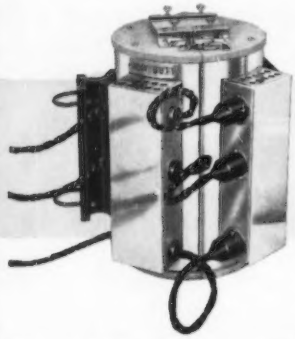
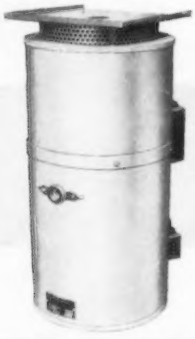


Split tube furnace has three zones of temperature control for operation to 2200° F. Heating chamber is 8" I.D. x 16" length with 4½" vestibules on each end that reduce heat losses and extend length of the uniform temperature zone.



Three zone, split tube, 2200° F. furnace has 2⅛" I.D. x 10" long heating chamber. Three built-in thermocouples provide easy temperature checks. Closing cover reduces stack effect, preventing loss of heat.



Solid tube furnace has 2⅛" I.D. x 18" long heating chamber, arranged in three zones of temperature control. A fused quartz window is set in the side of the furnace for viewing the specimen.

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(*Continued from page 74*)

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Monego, Edoardo, Via Gattamelata 45, Milan, Italy.

Newman, Percy Charles, inspector-in-charge, General Motors—Holden's Ltd., Elizabeth, South Australia.

Nuesa, Leonardo C., materials testing engineer, Bureau of Public Highways, Manila, Philippines. For mail: 1133 Washington, Sampaloo, Manila, Philippines.

Papillon, Gustave, vice-president and general manager, Ciment Quebec, Inc., St. Basile of Portneuf, P. Q., Canada.

Petridis B., George, manager, Electroquimica Venezolana, Av. 100, No. 103/42, Ap. 34, Valencia, Venezuela.

Rosendahl, Carl Henrik, chief metallurgist, Uddeholms AB, Munkfors, Sweden.

Sarabandi, Behnam, chemical engineer, Yousefabad Bala, Ave. Abnesina, Tehran, Iran. [A]

Stiefel, Ernst, manager, "Prometa" S. R. L., E. Zeballos 32, Rosario, Argentina.

Unger, Theodor Broch, Sr., chemical engineer, Den Norske Ingenirforening, Oslo, Norway. For mail: Fredrikstad, Norway.

Ward, Michael Allan, engineer, sales, Master Builders Co., Ltd., 7012 Euclid Ave., Cleveland, Ohio. For mail: 1030 Pacific Ave., Winnipeg 3, Man., Canada. [A]

Zoller, Heinz, plant manager, Kommerling GmbH, Chemische Fabrik, 133 Zweibruckerlandstr, Pirmasens/Pfalz, Germany.

OTS Research Reports

THESE REPORTS, recently made available to the public, can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Order by number.

Development of Durable Flame-Retardant Finishes for Cotton, PB 151550, $1.75.

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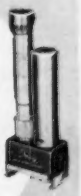

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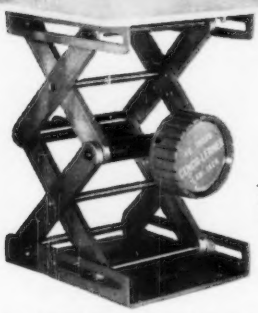

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Bookshelf

(*Continued from page 67*)

Minimum Property Standards for One and Two Living Units

U. S. Government Printing Office, Washington, D. C.; loose leaf, without binder; $1.75.

IN CARRYING out one of the purposes of the National Housing Act, namely, "to encourage improvement in housing standards and conditions," the Federal Housing Administration has established minimum property standards as outlined in this new publication. Previously, these standards were issued according to states and in a separate volume for each state covered. The new publication now establishes these standards on a national basis.

The standards are not intended to serve as a building code but to consider other aspects beyond the factors of health and safety, such as design and use. These aspects are essential for mortgage insurance determinations.

The contents are arranged in a very concise and logical arrangement with ample illustrations to assist the home owner and those not skilled in the construction field. The chapter on Materials and Products groups all construction materials, describes their requirements, and refers to recognized national standards. Prominent in these references are those relating to ASTM standards.

Effect of Surface on the Behaviour of Metals

Institution of Metallurgists (Br.) Refresher Lecture Course, 1957. New York Philosophical Library, Inc. (1958); 100 pp.; $10.00.

THIS PUBLICATION contains the four lectures concerning surface phenomena which were presented during the 1957 course. In the first paper, Dr. G. L. J. Bailey discusses the various methods of preparation and examination of surfaces; these being "pure," "clean," or "technical" surfaces which are to be studied for shape or topography, structure (microscopic and atomic), and composition. The paper gives a comprehensive, though not too detailed coverage of the various methods of investigation.

The lecture by Dr. T. P. Hoar gives a clear and concise picture of the relationship between surface cleaning methods and the subsequent behavior of the surfaces, emphasizing the electrochemical nature of these relationships.

Discussing the role of surface condition with respect to friction and wear, Dr. F. T. Barwell restricts his discourse to bearings and cut surfaces. The presentation gives a fair appraisal of what is recognized and what is conjecture, thus presenting a very equitable picture.

Within the limits of a single lecture, Mr. R. W. B. Stephens presents a good résumé of the various physical aspects of surface effects, covering electrical, thermal, and magnetic properties.

While this series of lectures provides but little for the mechanical metallurgist, for those interested in the physics and chemistry of surfaces it presents an excellent survey, with sufficient detail for emphasis.

L. L. WYMAN

Odor Measurement and Control

Proceedings of the Third Annual Symposium on Problems in Air Pollution, Franklin Inst. Laboratories, Phila., Pa., 1959, 82 pp., $3.

IN THE FIELDS of air and water pollution, odor is one of the most elusive problems. The nose is one of the most sensitive detection instruments known—we can smell, and be distressed by concentrations of contaminants which are so low that their detection and measurement by physical instruments is often difficult or even impossible. Under these conditions control and legal evaluation become difficult. At this symposium the problem was assessed by a group of experts from many walks of life who had a common interest in the problem of odor, whether in foods or other substances, water, or the air around us. The Proceedings include the six papers presented with discussion.

F. Y. S.

(*Continued on page 92*)

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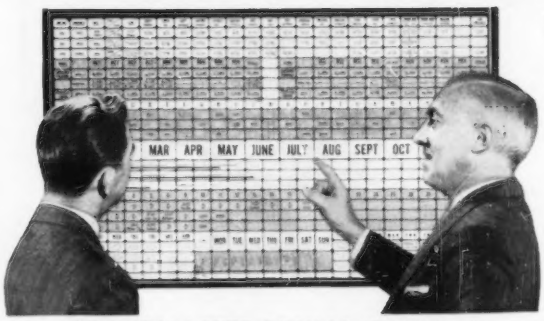

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September 27–30—**National Sand and Gravel and National Ready Mixed Concrete Assns.,** Semiannual Meeting, Lake Placid Club, Lake Placid, N. Y.

September 28–30—**American Oil Chemists' Society,** Fall meeting and exhibit, Hotel Statler, Los Angeles, Calif.

September 28–October 1—**Association of Iron and Steel Engineers,** Sherman Hotel, Chicago, Ill.

September 28–October 1—**American Welding Society,** Sheraton-Cadillac, Detroit, Mich.

September 30–October 2—Canadian Electrical Manufacturers Assn., Annual Meeting, Sheraton-Brock, Niagara Falls, Ont.

September 30–October 3—**American Ceramic Society,** Bedford Springs Hotel, Bedford, Pa.

October 4–7—**Society of Petroleum Engineers of AIME,** Fall Meeting, Memorial Auditorium, Dallas, Tex.

October 5–7—**American Gas Assn.,** Conrad Hilton Hotel, Chicago, Ill.

October 5–16—**Institute of the Aeronautical Sciences,** Biennial Anglo-American Conference, Hotel Astor, New York, N. Y.

October 6–9—**American Council of Independent Laboratories,** Annual Meeting, Clift Hotel, San Francisco, Calif.

October 7–9—**Institute of Radio Engineers,** Canadian Convention, Toronto, Ont.

October 7–9—**American Vacuum Society, Inc.,** 6th National Symposium on Vacuum Technology, Sheraton Hotel, Philadelphia, Pa.

October 7–10—**American Association of Textile Chemists & Colorists,** Sheraton-Park & Shoreham, Washington, D. C.

October 8—**American Ordnance Assn.,** Annual Meeting, Aberdeen Proving Ground, Md.

October 8–10—**American Society of Tool Engineers,** Semiannual Convention, Chase-Park Plaza Hotels, St. Louis, Mo.

October 11–16—**American Institute of Electrical Engineers,** Fall Meeting, Chicago, Ill.

October 12–14—**Association of Official Agricultural Chemists,** Annual Meeting, Shoreham Hotel, Washington, D. C.

October 12–15—**Technical Association of the Pulp and Paper Industry,** Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

October 12–15—**The Wire Assn.,** Statler Hotel, Cleveland, Ohio

October 13–14—**Society of Plastics Engineers,** National Technical Conference, Ambassador Hotel, Los Angeles, Calif.

October 15–17—**National Society of Professional Engineers,** The Olympic Hotel, Seattle, Wash.

October 18–22—**The Electrochemical Society,** Deshler-Hilton Hotel, Columbus, Ohio.

October 19–20—**American Coke and Coal Chemicals Inst.,** Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

October 19–23—**American Society of Civil Engineers,** Annual Convention, Hotel Statler, Washington, D. C.

October 19–23—**American Public Health Assn.,** Annual Meeting, Convention Hall, Atlantic City, N. J.

October 20–22—**American Standards Assn.,** National Conference on Standards, Sheraton-Cadillac, Detroit, Mich.

October 20–24—**Federation of Paint and Varnish Production Clubs,** Annual Meeting and Paint Industries Show, Convention Hall, Atlantic City, N. J.

October 21–23—**Society for Experimental Stress Analysis,** Annual Meeting, Hotel Pick Fort Shelby, Detroit, Mich.

October 22–24—**Acoustical Society of America,** Fall Meeting, Wade Park Manor Hotel, Cleveland, Ohio.

October 26–28—**Association of Analytical Chemists,** 7th Anachem Conference, Wayne State University, Detroit, Mich.

October 27–29—**American Society of Mechanical Engineers and American Institute of Mining, Metallurgical and Petroleum Engineers,** Solid Fuels Conference, Netherland Hilton Hotel, Cincinnati, Ohio

October 29–30—**National Slag Assn.,** Annual Meeting, Boca Raton Hotel, Boca Raton, Fla.

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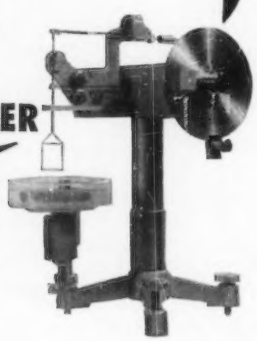

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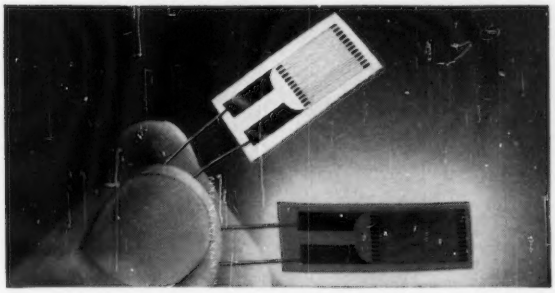

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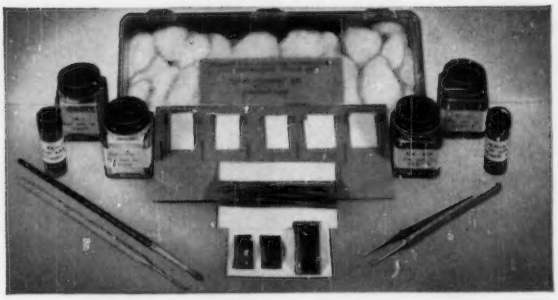

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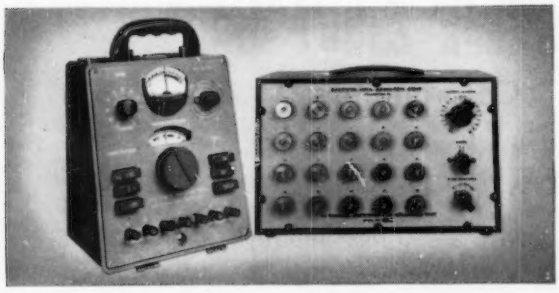

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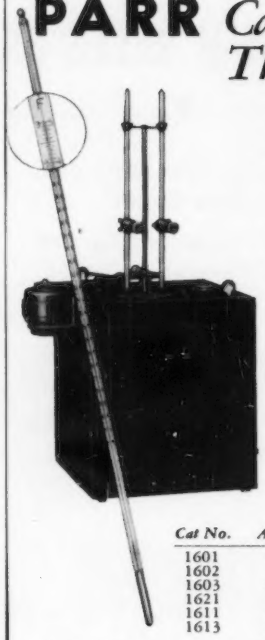

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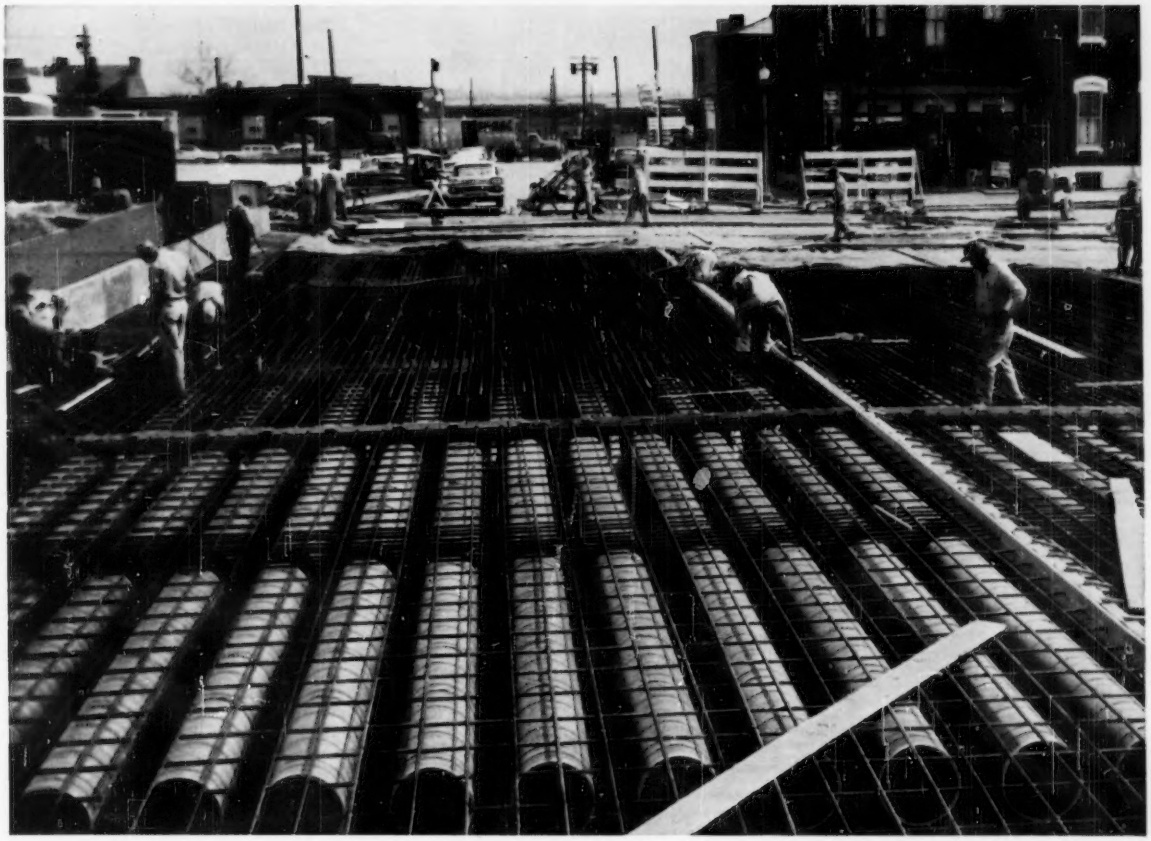

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NEWS OF MEMBERS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

At the Annual Meeting of the Metal Powder Industries Federation, ASTM members numbered among the re-elected officers: **George A. Roberts,** vice-president, technology, Vanadium Alloys Steel Co., Latrobe, Pa., was re-elected president; **Kempton H. Roll** was reappointed executive secretary and treasurer; and **Norbert K. Koebel,** manager, Heat Treating Furnace Div., Lindberg Engineering Co., Chicago, Ill., was elected a director of the Powder Metallurgy Equipment Ass'n., Division of MPI.

William F. Amon, Jr., is now with Keuffel & Esser, Hoboken, N. J., as market planning director. Formerly he was associate director, Narmco Industries, Inc., San Diego, Calif.

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Dan Bailey, previously ordnance engineer, Kirk Engineering Co., Los Angeles, Calif., is now consulting engineer, Capitol Service Co., Santa Monica, Calif.

A. M. Bain, plate and boiler engineer, Dominion Bridge Co. Ltd., Montreal, Canada, has been appointed chief engineer, Platework Div.

Kenneth E. Baird, a member of ASTM since 1947, retired July 1, 1959. He was chief chemist, Philadelphia Coke Div., Eastern Gas and Fuel Assn., Philadelphia, Pa. Mr. Baird served on Committee D-3 on Gaseous Fuels for many years, and also on Committee D-19 on Industrial Water.

F. M. Barry retired June 1, 1959, as director of research, Scovill Manufacturing Co., Waterbury, Conn. Mr. Barry represented his company's sustaining membership in the Society, and for over 30 years has been active in ASTM technical committees. He participated in the work of Committee B-2 on Non-Ferrous Metals and Alloys, B-5 on Copper and Copper Alloys, B-3 on Corrosion of Non-Ferrous Metals and Alloys, B-7 on Light Metals and Alloys, B-8 on Electrodeposited Metallic Coatings, E-3 on Chemical Analysis of Metals, and E-4 on Metallography.

Ray T. Bayless, a member of ASTM since 1919, retired September 1, 1959, as assistant secretary of the American Society for Metals. He is a member of the ASTM Cleveland District Council, having served as secretary from 1942 to 1948, vice-chairman from 1948 to 1950, and chairman from 1950 to 1954. In recognition of 40 years of Society membership, Mr. Bayless was presented with a certificate at the 62nd Annual Meeting.

Charles W. Blacketer, previously technical adviser, Sinclair & Valentine Co., Inc., Kansas City, Mo., is now technical director, Revilo Paint and Varnish Co., Inc., Kansas City, Mo.

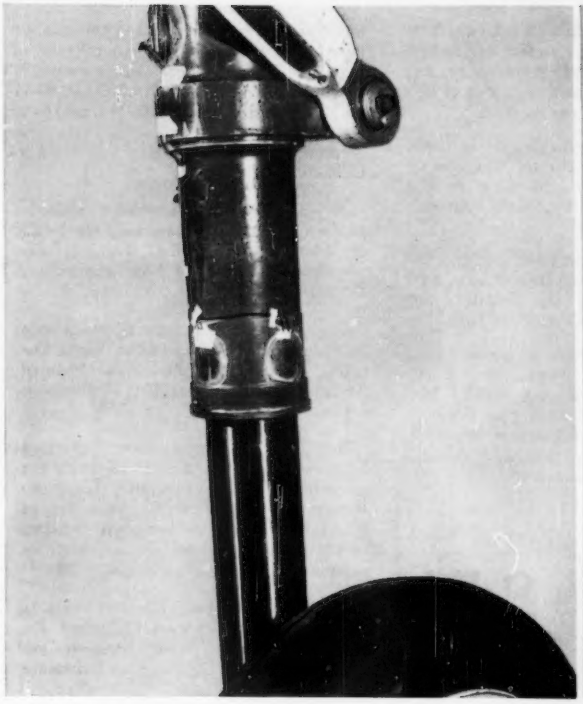
William C. Bowden, Jr., retired September 1, 1959, as technical director, Ledoux and Co., 359 Alfred Ave., Teaneck, N. J. Mr. Bowden resigned from ASTM technical committees A-9 on Ferro Alloys, B-2 on Non-Ferrous Metals and Alloys, and E-3 on Chemical Analysis of Metals, on which he had served for many years, but will continue as a councilor for the New York District.

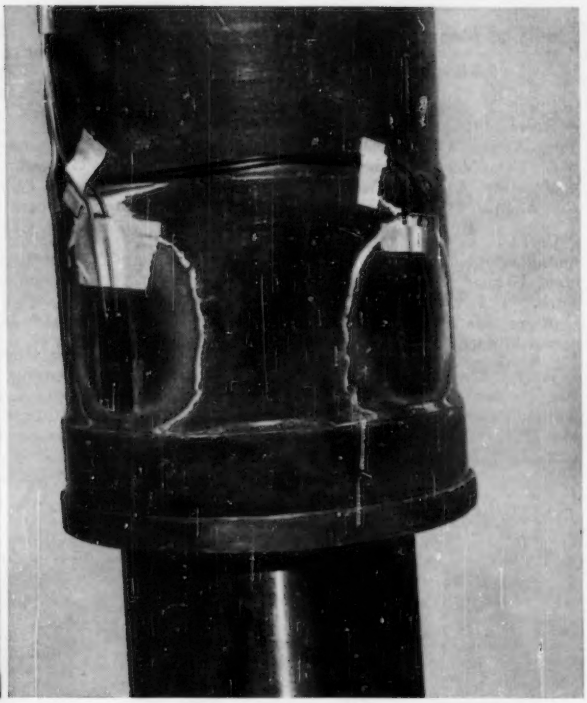
J. Hartley Bowen, Jr., superintendent, High Polymer Div., Aeronautical Materials Laboratory, Naval Air Material Center, Phila., Pa., has been appointed technical director.

Lewis G. Bricker, formerly chief chemist, E. L. Conwell and Co., Phila., Pa., was appointed chief chemist, Ambric Testing and Engineering Associates, Inc., Phila., Pa. At the same time he was elected to the board of directors.

F. R. Bridges, previously vice-president, Fyr-Fyter Co., Newark, N. J., is chief engineer, Couch Ordnance, Inc., N. Quincy, Mass.

(*Continued on page 86*)





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News of Members

(*Continued from page 84*)

Byron F. Campbell, is now executive engineer of Ingersoll Kalamazoo Div. of Borg-Warner Corp., Kalamazoo, Mich. Mr. Campbell had been director of engineering, Clinton Machine Co., Clinton, Mich.

Carlton E. Carrigan, until recently metallurgist, Fairchild Engine Div., Fairchild Engine and Airplane Corp., Deer Park, L. I., N. Y., is now assistant manager, Materials and Metallurgy, Reaction Motors, Denville, N. J.

James M. Cassel, Leather Section, Organic and Fibrous Materials Div., National Bureau of Standards, Washington, D. C., was the recipient of the Alsop Award for 1959. This award, which is the highest honor given for meritorious work in the field of leather chemistry, was presented at the annual meeting of the American Leather Chemists Assn.

Stanley L. Channon, previously head, Metallurgical Dept., Hunter Engineering Co., Riverside, Calif., is now in the Engineering Laboratory, Rohr Aircraft Corp., Riverside, Calif.

J. A. Claussen recently retired from the American Iron and Steel Inst., Alexandria, Va. He represented the Institute on ASTM Committee A-3 on Cast Iron.

Simon Collier, director of quality control, Johns-Manville Corp., New York, N. Y., retired June 30, 1959. Mr. Collier, a past-director of the Society, will continue his membership, which dates back to 1926, and will continue to be active on the technical committees of which he is a member. He is currently serving as chairman of Committees D-11 on Rubber and Rubber-like Materials and E-11 on Quality Control of Materials, and secretary of Committee C-17 on Asbestos-Cement Products.

H. D. Comins, formerly assistant professor of civil engineering, University of Florida, Gainesville, Fla., is now associate professor of civil engineering, University of Missouri, Columbia, Mo.

George S. Cook is now assistant sales manager, Specialty Resins Co., Santa Ana, Calif. Previously he was chemist, Archer-Daniels-Midland Co., Minneapolis, Minn.

Ray B. Crepps, professor, Structural Engineering Dept., School of Civil Engineering, Purdue University, Lafayette, Ind., retired June 30, 1959. Prof. Crepps, who joined ASTM in 1920, will continue his membership and remain active on the committees he is now serving.

Arthur C. Dreshfield, formerly chemical engineering consultant, La Grange, Ill., is now director, paper research and development, The Glidden Co., Baltimore, Md.

Francis T. Eddy is now vice-president, Bayside Industries, Inc., Costa Mesa, Calif. Formerly he was assistant manager, Technicraft Laboratories, Inc., Thomaston, Conn.

W. J. Emmons, associate dean and secretary, College of Engineering, University of Michigan, Ann Arbor, Mich., retired June 30, 1959. Dean Emmons has been a member of the Society for over 30 years, earlier as an individual member and later as representative of the university's Transportation Engineering Div. For the same number of years, he served on Committee D-4 on Road and Paving Materials, having been secretary from 1946 to 1948.

J. H. Foote, president, Commonwealth Associates, Inc., Jackson, Mich., was elected president of the American Institute of Electrical Engineers. Mr. Foote has been a very active member of ASTM since 1940 and has served on many administrative and technical committees. He served as a director of the Society from 1942 to 1944 and from 1946 to 1949. Since 1945 he has been a member of the Administrative Committee on Standards, of which he is now chairman. He represented the Society on the ASA Standards Council and is now serving on its board of directors. Mr. Foote actively participates in the work of Committee B-1, having been chairman from 1938 to 1950.

Alexander Gobus, director, nondestructive testing, Philips Electronics, Inc., Mt. Vernon, N. Y., received the Noah A. Kahn Memorial Award for 1959 from the Metropolitan Chapter of the Society for Nondestructive Testing in recognition of his many contributions to this field.

(*Continued on page 88*)

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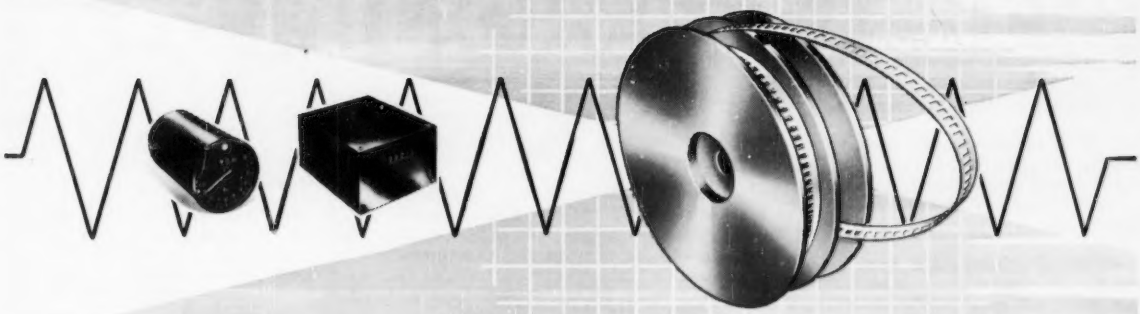

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News of Members

(*Continued from page 86*)

A. Kenneth Graham, president, Graham, Savage & Associates, Jenkintown, Pa., and a long-time member of ASTM Committee B-8 on Electrodeposited Metallic Coatings, received the Scientific Achievement Award of the American Electroplaters' Society. Mr. Graham is the second person to receive the Society's highest scientific honor. The award was presented during the Golden Jubilee Convention and Industrial Finishing Exposition.

L. W. Grayson, chemical engineer and general manager, City of Glendale, Public Service Dept., Glendale, Calif., was elected president of the American Water Works Assn.

Norman D. Groves has been named assistant manager of research in charge of chemistry and physics, Carpenter Steel Co., Reading, Pa.

Marvin B. Happ, formerly chief metallurgist, Walworth Co., S. Baintree, Mass., is now assistant general manager, Tang Industries, Waltham, Mass.

Charles C. Hartman, chemist, National Bureau of Standards, Washington, D. C., retired June 30, 1959. For many years, Mr. Hartman served on ASTM Committee D-1 on Paint, Varnish, Lacquer and Related Products and headed the American Group advisory to the ASA on ISO TC/50 on Lac.

H. Bert Hood is now head, Special Test Dept., Pittsburgh Testing Laboratory, Pittsburgh, Pa. Formerly he was a professional engineer at Apollo, Pa.

George L. Jenkins, formerly member of the technical staff, Hughes Aircraft Co., Culver City, Calif., is now member, technical staff, Space Technology Laboratories, Inc., Sherman Oaks, Calif.

Carl F. Joseph, technical director, Central Foundry Div., General Motors Corp., Saginaw, Mich., has been awarded the McCrea medal by the Malleable Founders Society for "his long-standing success in the field of metallurgy and in more recent years his wonderful contribution in the field of pearlitic malleable."

John D. Lewis was made sales manager, Steel and Tubes Div., United States Pipe and Foundry Co., Burlington, N. J. Previously he was manager, technical services.

Charles H. Marshall retired January 31, 1959 from the Testing Equipment Dept., Baldwin-Lima-Hamilton Corp., Phila., Pa. Mr. Marshall joined the Society in 1919, and since 1927 has been active in the work of Committee E-1 on Methods of Testing. At the 62nd Annual Meeting, Mr. Marshall was presented with a certificate in recognition of his 40 years of membership in the Society.

S. E. Maxon recently retired from the New Jersey Zinc Co., New York, N. Y. For almost 30 years Mr. Maxon has been active in committee work, having served on Committees A-5 on Corrosion of Iron and Steel, A-9 on Ferro-Alloys, B-6 on Die-Cast Metals and Alloys, B-8 on Electrodeposited Metallic Coatings, and D-14 on Adhesives.

Raymond C. Perlett, 1760 Watchung Ave., Plainfield, N. J., retired June 30 after a 40-year career with Johns-Manville Corp He is now a technical advisor to the National Insulation Manufacturers Assn.

James Prophet, Jr., formerly head, Experimental Laboratory, Esso Standard Oil Co., Bayonne, N. J., is now chemist, Moore & Munger, New York, N. Y.

C. Arnold Richards, geologist, 249 Concord St., Glendale, Calif., is now administrative geologist for the City of Los Angeles, Calif.

E. B. Saubestre, assistant research director, Enthone, Inc., New Haven, Conn., has been promoted to technical director. Mr. Saubestre received the George B. Hogaboom Award for the best paper on nickel plating appearing in the American Electroplaters' Society's publications for the fiscal year.

H. G. Schurecht has retired from the Champion Spark Plug Co., Detroit, Mich. He represented his company on ASTM Committees C-21 on Ceramic Whitewares and Related Products and C-22 on Porcelain Enamel.

Antonio Scortecci, professor of metallurgy and metallography, University of Genoa, and vice-president, Italian Association of Metallurgy, Milan, Italy, was

(*Continued on page 90*)

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Properly identified leads for the cathode and the anode with forceps for contacting or holding the specimen are supplied. A replaceable beaker and fitted cathode clip to support either the vertical or horizontal stainless steel cathode are furnished.

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FOR FURTHER INFORMATION CIRCLE 311 ON READER SERVICE CARD

News of Members

(*Continued from page 88*)

awarded the Le Chatelier Medal of the Société Française de Metallurgie in recognition of his metallurgical achievements.

Carlos F. Secada is now industrial architect, C. F. Secada, S. A., San Isidro, Lima, Peru. Previously he was industrial engineer, A. F. Wiese, Ing., S. A., Lima, Peru.

Sherwood B. Selley, formerly technical director, Joseph Dixon Crucible Steel Co., Jersey City, N. J., has been named vice-president in charge of research.

Howard N. Smith is textile engineer, U. S. Testing Co., Inc., Hoboken, N. J. Formerly he was textile technologist, William L. Barrell Co., Inc., New York, N. Y.

Eugene R. Smoley, vice-president, The Lummus Co., 385 Madison Ave., New York, N. Y., is retiring after 25 years of service. Mr. Smoley will continue to serve as a consultant to the petroleum and chemical industry on a part-time basis.

C. Richard Soderberg, previously dean of the School of Engineering, Massachusetts Institute of Technology, Cambridge, Mass., has been named an institute professor.

J. R. Stitt, research engineer, The R. C. Mahon Co., Detroit, Mich., was elected a director-at-large of the American Welding Society.

Michael J. Sullivan is now a chemist with Arizona Fertilizers, Inc., Phoenix, Ariz. Mr. Sullivan was formerly director, Valley Laboratories, Inc., Phoenix, Ariz.

George P. Swift, consulting engineer, Watertown, Mass., was elected to Honorary Membership at the Golden Jubilee Convention of the American Electroplaters' Society. This recognition was awarded Mr. Swift because of his distinguished record, he having served as president of AES in 1953–1954.

Manuel Tama was made vice-president in charge of Ajax Engineering Div., Ajax Magnethermic Corp., Trenton, N. J. Formerly Mr. Tama was president of Ajax Engineering Corp.

Ernest G. Tomlinson, formerly hydraulic engineer, The Pennsylvania State Department of Forests and Waters, Harrisburg, Pa., is now borough manager, Borough of Middletown, Middletown, Pa.

John Tully is now associate engineer, Thiokol Chemical Corp., Ogden, Utah. Previously he was associate development engineer with Marquardt Aircraft Co., Van Nuys, Calif.

Karl Unholtz, previously chief engineer, The MB Manufacturing Co., Inc., New Haven, Conn., is now vice-president, Unholtz-Dickie Corp., Hamden, Conn.

(*Continued on next page*)

News of Members

John van Venrooy is now research chemist, Sun Oil Co., Marcus Hook, Pa. Previously he was specialist in fibers, Rayonier, Inc., Whippany, N. J.

Thomas P. Wharton, formerly vice-president, Container Laboratories Inc., Washington, D. C., is now president of Packaging Consultants, Inc., Washington, D. C.

H. H. Wilder, manager, engineering sales, Vanadium Corporation of America, Chicago, Ill., has received the 1959 Award of Scientific Merit of the American Foundrymen's Society "for noteworthy contributions to the Society and its membership in furthering the technology of ferrous castings and their acceptance."

Ralph J. Wirshing, head, Chemistry Dept., General Motors Research Laboratories, Detroit, Mich., retired after 41 years of service, but will continue to serve in a consulting capacity. Mr. Wirshing's ASTM activities included technical committee D-1 on Paint, Varnish, Lacquer and Related Products on which he served since 1944, Administrative Committee on Papers and Publications, Joint ALCA-ASTM Committee on Leather, and the Detroit District Council.

DEATHS . . .

M. A. Arnan, director, The Standards Institution of Israel, 200 Dizengoff Rd., Tel Aviv, Israel (December, 1958). Mr. Arnan joined the Society in 1932.

C. S. Brainin, a long-time member of the Society, partner and manager, C. S. Brainin Co., 320 Washington St., Mt. Vernon, N. Y. (July, 1959). Mr. Brainin had been a member of Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts since 1941.

Martin Frisch, vice-president, Foster Wheeler Corp., New York, N. Y. (June 16, 1959). Mr. Frisch represented his company in Society membership for a number of years.

John R. Giese, partner, Modjeski-Masters, Box 167, Harrisburg, Pa. (May 31, 1959). Mr. Giese served on Subcomittee I of the AWS-ASTM Joint Committee on Filler Metal since 1944.

Fred A. Jones, Canton, Ohio (October 15, 1958). Mr. Jones joined the Society in 1920, and since 1928 was a member of Committee C-7 on Lime. In recognition of his long and faithful service to the committee, he was elected to honorary membership in 1948.

Harry E. Lewis, general manager, M. H. Detrick Co., Insulation Div., 111 W. Washington St., Chicago, Ill. (July 21, 1959). For many years, Mr. Lewis was active in the work of Committee C-16 on Thermal Insulating Materials.

A. D. McLeod, representative of the Erie Bolt and Nut Co., Erie, Pa., on Committee A-1 on Steel (recently).

Dalton G. Miller, materials engineer (retired), Bureau of Public Roads, U. S. Dept. of Commerce, University of Minnesota, University Farm, St. Paul, Minn. (June 26, 1959). Mr. Miller joined the Society in 1924 and over the years was active in several technical committees. At the time of his death, he was chairman of Committee C-4 on Clay Pipe, which committee he had served for 25 years. For long and faithful service to Committees C-1 on Cement and C-15 on Manufactured Masonry Units, Mr. Miller was elected to Honorary Membership on both committees.

An outstanding contribution by Mr. Miller was his work as chairman of the Subcommittee on Drain Tile in which capacity he supervised the complete revision of the twenty-year-old specification for Drain Tile (C-4), long an accepted standard in the drainage field. He was a well known authority on drainage problems.

Lewis S. Reid, Linden Lane, Chatham, N. J., retired general purchasing agent, Metropolitan Life Insurance Corp., New York, N. Y. (July 15, 1959). Mr. Reid joined ASTM in 1930 and since that time had been active in many phases of its work. He participated in the activities of technical Committees A-8 on Magnetic Analysis, B-2 on Non-Ferrous Metals and Alloys, D-13 on Textile

(*Continued on next page*)

STATIC FATIGUE TESTS WITH GREGG TENSION RING

The Gregg Tension Ring is a small and simple device for applying and maintaining a load on a notch stress rupture specimen. The load is applied to the test specimen through the elastic ring and is measured by the change in diameter. The ring and time control base is shown on the left and the ring and loading fixture is below. Tests can be conducted to evaluate the effects embrittlement or delayed failure characteristics of high strength steel parts. Each ring is calibrated by applying compression loads on the loading assembly by means of a universal testing machine and measuring the corresponding inside diameter.

Model No.	Wall Thickness	Outside Diameter	Max. Load
CS-106 A	0.250 in.	7.125 in.	3,000 lbs.
CS-106 B	0.375 in.	7.125 in.	10,000 lbs.

(Others upon request.)

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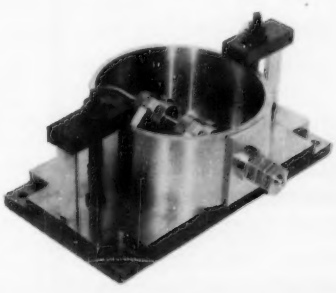

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Deaths

(*Continued from preceding page*)

Materials, D-6 on Paper and Paper Products, serving as secretary from 1937 to 1940 and chairman from 1940 to 1948, D-12 on Soaps and Other Detergents, D-9 on Electrical Insulating Materials, E-1 on Methods of Testing, D-21 on Wax Polishes and Related Material and had been a member of the New York District Council. In addition, he served on the Administrative Committee on Papers and Publications and the Administrative Committee on Standards. Mr. Reid also represented ASTM on ASA Sectional Committee X-2 and on ASTM-TAPPI Joint Coordinating Committee. In June 1959, Mr. Reid was awarded the ASTM Award of Merit.

Albert P. Spooner, 1811 Sycamore St., Bethlehem, Pa., metallurgical engineer, retired, Bethlehem Steel Co., Inc. (August 3, 1959). A member of the Society for almost 40 years, Mr. Spooner was very active in the work of the committees dealing with steel, and his contributions to the standards program in particular were of great value. He served on Committees A-1 on Steel, A-3 on Cast Iron, A-5 on Corrosion of Iron and Steel, A-9 on Ferro-Alloys, A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, B-5 on Copper and Copper Alloys, and E-7 on Nondestructive Testing.

Bookshelf

(*Continued from page 78*)

A Record of History and Evolution of Early American Bridges

Llewellyn Nathaniel Edwards; University Press, Orono, Me.; 1959; 50 photographs; 240 pp.; $5.

THE BRIDGE HAS long been a symbol of man's striving to overcome obstacles, to reach new lands, to communicate with new people. Thus the building of bridges has been imbued with an aura of romance and adventure matched by few other of man's endeavors. The men who toil today to hurl ever larger chunks of hardware into orbit are really bridge builders—they are laying the foundations for the biggest bridges of all, that will take us to undreamed lands.

Bridges had been Dr. Edwards' profession as well as his hobby for all of his 40-year professional life. While achieving a high place in his profession of bridge design and construction, Dr. Edwards accumulated possibly one of the most extensive libraries in existence on the subject of bridge engineering. This history grew out of his hobby, and it is written with the sure knowledge of a man well versed in his field.

Dr. Edwards begins his story with descriptions of some of the great natural bridges on this continent. He then visualizes the beginnings of the beam-type bridge and the suspension bridge in the accidental fall of a tree or swaying of a vine across a stream. Aboriginal bridges are described through excerpts from the notes of early explorers in the Western World. Then from the Colonial up through the post-Civil-War period, details of bridge design and construction are described in a knowledgeable and interesting way, often in the words of the craftsmen themselves. In addition to the engineering features of many bridges, accounts are given of their service, their failures and successes, and their eventual fate. The fascinating interplay of economics, technology, and personalities provides the solid overtones of a true history.

This book is obviously a labor of love. To anyone interested in bridges, either from the engineering or the historical viewpoint, it will provide enjoyable reading and valuable background.

A.Q.M.

Behavior of Metals at Elevated Temperatures

Philosophical Library, 15 E. 40th St., New York 16, N. Y., (1957); 122 pp.; Illus.; $6.00.

THIS BRIEF BOOK includes four lectures delivered in 1956 in a "refresher course" sponsored by the Institution of Metallurgists (British).

The first lecture, by N. P. Allen, superintendent, Metallurgy Div., National Physical Laboratory, entitled "The Engineering Properties of Metals at High Temperatures," is concerned with the effect of temperature on flow and fracture under constant as well as fluctuating stresses and temperature, and with the effect of temperature on such properties as elastic constants, thermal expansivity and resistance to chemical attack.

A second lecture, by G. E. Meikle of the Ministry of Supply, is entitled "The Effect on Metals of Temperatures up to 450 C." This paper is concerned with the application of aluminum, magnesium, titanium, and iron alloys in airplanes and missiles.

A third lecture, by L. B. Pfeil, director of the Mond Nickel Co., entitled "Non-Ferrous High Temperature Materials," concerns temperatures above about 500 C.

The final lecture on "High-Temperature Steels" was prepared by W. E. Bardgett of the United Steel Companies Ltd. and deals with carbon steels, low-alloy steels, intermediate alloy steels, 12 per cent chromium steels, and austenitic steels.

Each of the lecturers is eminently qualified for his assignment, and the papers will be of interest and value to those metallurgists and engineers who, having already a general knowledge of the behavior of metals at elevated temperatures, wish to bring themselves up to date (as of 1956) on developments in the several specific fields dealt with.

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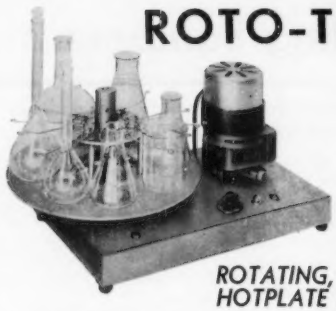

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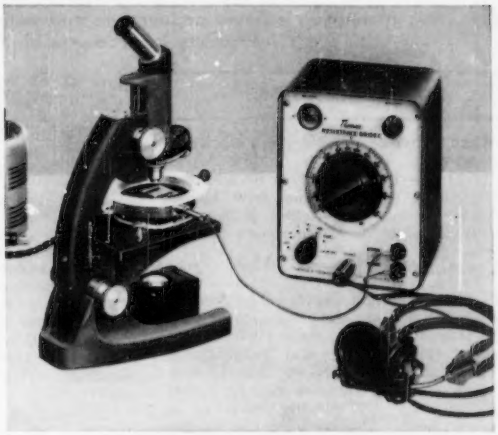

. . . for determining melting points by use of a thermistor in place of mercury-in-glass thermometers

AUDIOHM THERMISTOR ACCESSORIES, for use with any Thomas-Kofler Hot Stage. Replace stage-calibrated thermometers and provide an audible signal which *eliminates the necessity for removing the eye from the microscope.* They offer faster response because the smaller sensor can be located closer to the field of observation than is possible with a thermometer. This sensor covers the entire temperature range up to 350°C.

Uninterrupted observation of fusion through all phases is made possible by measuring temperature as a function of thermistor resistance, which can be determined at any given instant by manually nulling the audible bridge signal. A simple graphic reader converts resistance values directly to temperature readings.

The Bridge Alarm (not shown above) signals approach to a preset balance point, permitting the operator to leave the stage unattended while it heats or cools.

6887-C2. Audiohm Thermistor Hot Stage Assembly, Thomas-Kofler, complete as illustrated, consisting of Hot Stage with transformer, Thermistor Attachment for the stage, Audiohm Resistance Bridge, Earphones, and Thermistor Temperature Computer; without miscroscope or bridge alarm. For 115 volts, 50 or 60 cyc. a.c. **422.95**

6887-B. Thermistor Hot Stage Attachment, for use on any Thomas-Kofler Hot Stage **50.25**
3963-A5. Resistance Bridge, Thomas Audiohm **228.00**
3963-A7. Bridge Alarm, Buzzer Type, Thomas (not shown above) **58.50**
3950-M2. Earphones **12.00**
6884-F. Thermistor Temperature Computer, Thomas **20.00**

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NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note. This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

LABORATORY ITEMS

Wear Tester—The Alpha lubricant-friction-wear testing machine (Model LFW-1) has been modified to add two new testing speeds. The new speeds serve to increase the original multi-speed operating range of the machine in two directions.
The Alpha-Molykote Corp. 3166

Plastic Deflection Tester—The Aminco plastic deflection tester indicates the deflection of thermoplastics when subjected to various loads and temperatures in accordance with ASTM Test D 648. As many as four samples can be tested simultaneously by placing each in a specimen holder and lowering the holders into an insulated bath. Deflections are indicated on dials mounted on the specimen holders.
American Instrument Co., Inc. 3167

Ionization Chamber—New spherical gas phase ionization chambers and a new slide chamber for solid and liquid samples have been added to the line of Cary instruments manufactured.
Applied Physics Corp. 3168

Soils Survey Instrument—A portable instrument, the Vibroground Model 274-M, gives data for soil studies in connection with foundation design, road building, burrow sites, bedrock determinations, pipeline locations and similar construction work.
Associated Research, Inc. 3169

Surface Thermometer—A new electronic surface thermometer indicating accurate temperature measurements down to −328 F has been announced. The thermometer offers response times (time constant) of less than 1 sec (0.72 sec) in liquids and 2.2 sec on surfaces. Full reading responses are 5 and 15 sec respectively.
Atkins Technical, Inc. 3170

Modulation Test Set—New Model T97 modulation test set, a high accuracy unit for providing direct frequency and voltage modulation readings on 400 cps systems has been announced. Designed for field or laboratory use, the Model T97 measures modulation, stability characteristics, and transients of aircraft and ground power systems.
Avtron Manufacturing, Inc. 3171

Electroplater's Microscope—A new electroplater's microscope designed to provide rapid, accurate measurements of plating thickness with the same high quality results as instruments which are considerably more expensive is announced.
Bausch & Lomb Optical Co. 3172

Water Demineralizer—The Betz Laboratory Demineralizer is a self-contained, portable unit for either laboratory or plant use. It will remove all but minute traces of ionized solids from the water including weakly ionized materials such as silica and carbon dioxide, and thereby produce water of much higher quality than is possible by distillation.
Betz Laboratories, Inc. 3173

Servo Amplifiers—The availability of three new servo amplifiers (3.5 w, 6 w, 12 w) for continuous operation in a temperature range of −55 to +125 C has been announced.
Bulova Watch Co., Electronics Div. 3174

Micro Accessories—These accessories extend the usefulness of Coleman Junior

(*Continued on next page*)

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The most unique and complete instrument checking set.

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Laboratory Items

spectrophotometers in microchemical analysis. Precise spectrophotometric measurements are possible through a full 1.0 cm solution path in an arrangement which requires a solution volume of only 0.7 ml.
Coleman Instruments, Inc. 3175

Shock Tester—A compact shock tester which repeats either of a choice of two widely specified shock pulses in rapid succession is announced. Designed for on-the-line testing of high-volume production items, this new Hyge-6500 can perform a complete test cycle every minute.
Consolidated Electrodynamics Corp., Rochester Div. 3176

Seals—Announcement is made of an entirely new type of O-ring seal fitting with tapered pipe threads, permitting connection to an existing female pipe thread and securing a positive seal without the use of contaminating sealants. Useful for laboratory work.
Crawford Fitting Co. 3177

Distortion Tester—A distortion tester indicating the deflection of thermoplastics subject to various loads and temperatures in accordance with ASTM Designation D 648 has been announced.
Custom Scientific Instruments, Inc. 3178

Temperature Recording System—Designed to measure and record up to 75 iron constantan thermocouple inputs, the system can be used in engine test work, in process monitoring, and other applications where periodic, accurate recording of temperatures is desired on either round-the-clock or intermittent basis. The digital output is presented automatically on an electric typewriter.
Datex Corp. 3179

Water Bath Shakers—Two new water bath shakers with deep stainless steel baths are announced. Temperature control is from ambient to 80 ± 0.5 C. Speed of shaking is selective in a wide range; stroke length is adjustable; water level device adjusts and maintains bath depth; operation is practically silent.
Eberbach Corp. 3180

Scratch Microscope—Recent attachments for the Hilger & Watts scratch investigation microscope now permit its use for measuring scratches and pits on the external surface of extruded metals with diameters ranging from 0.125 to 3 in.
Engis Equipment Co. 3181

Transistorized Tachometers—A line of transistorized tachometers, Model 7120 Series, having a dual function—measurement of speed without physical loading, and control of associated circuitry such as overspeed and underspeed control circuits—has been announced.
Electro Products Laboratories 3182

Gas Chromatography—Speed and versatility marks the new Model 202 linear programmed temperature gas chromatograph. By linearly increasing the column temperature during a run, separate, well-defined sharp peaks have been observed for samples containing C_1 to C_{10} fatty acids, C_1 to C_{26} fatty-acid esters, and gaseous mixtures containing the permanent gases (including carbon dioxide), light petroleum gases, etc.
F & M Scientific Corp. 3183

Thermistor Probes—Thermistor probes with identical resistance-temperature characteristics are now available in production quantities. Two standard probes are offered. Absolute resistance of each probe is given in 1 F increments from 0 to 350 F. Resistance changes from 26,520 ohms at 0 F to 70.4 ohms at 350 F indicate the great sensitivity obtainable.
Fenwal Electronics, Inc. 3184

Chlorine Analyzer—A new residual chlorine analyzer featuring Micro-Ball self-cleaning electrodes is currently being manufactured and marketed. Known as the "Depolox," the new analyzer generates a current, by means of two dissimilar metal electrodes, in proportion to the amount of free or total residual chlorine in the line. Residual is recorded in parts per million on standard recorder charts.
Fischer & Porter Co. 3185

Pipe Tester—New Model PT-250 pipe testing machine has a loading capacity of 500,000 lb. Designed to accommodate pipe in 8-ft lengths, up to 144-in. diam, the frame can be extended in width to accommodate pipe in 16-ft lengths.
Forney's Inc. 3186

Decay Calculator—This special slide rule will calculate the activity of radioactive iodine, gold, and phosphorous after an elapsed period of time.
Graphic Calculator Co. 3187

Planning Kit—A kit containing material for planning a graphic visual control is announced for the Boardmaster system. This new package of visual aid information has many suggestions for picturing data graphically.
Graphic Systems 3188

Voltage Source—Especially useful in the design of amplifiers, the new Gyra reference voltage source, Models RVS-100 and RVS-100c provide precision regulation, continuously variable from 0 to 600 v in steps of 0.0001 v.
Gyra Electronics Corp. 3189

Magnetic Specimen Holder—A magnetic specimen holder that can be used with any inverted metallurigal microscope is now available. This holder permits convenient survey of specimens without embedding them. The holder has a vertically adjustable magnetized carrier. Using plasticine or the like and a specimen press, the sample is attached to a metal object slide which is then placed under the magnet of the specimen holder.
Wm. J. Hacker & Co., Inc. 3190

Portable Voltmeter—A battery-operated, general-purpose a-c voltmeter with a useful frequency range of 1 to 1 million cps is now available. The voltmeter, Model 403A, is a transistorized, compact instrument weighing less than 5 lb.
Hewlett-Packard Co. 3191

Radioactive Testing—The remote control design of Instron Models TT-C and TT-B physically separates the loading frame from the control console, allowing for control of the testing assembly outside the radiation area.
Instron Engineering Corp. 3192

Glassware—The availability of a wide line of Kimax tempered glass pipe and fittings manufactured from KG-33 borosilicate glass is announced.
Kimble Glass Co. 3193

(*Continued on page 96*)

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To Terminate Distillations
To Control Temperatures
To Control Liquid Levels

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Laboratory Items

(*Continued from page 95*)

Electronic Galvanometer—An all electronic, high-sensitivity galvanometer, Model 204A, which can also function as a d-c null detector, linear deflection indicator, microvolt-ammeter or inverting d-c amplifier, is now available.
KIN TEL Div.
Cohu Electronics, Inc. 3194

Laboratory Connectors—New connectors are available for glass and metal tubing. Only Teflon is in contact with the fluids. This makes it possible to handle a wide variety of acids, solvents, and highly reactive chemicals without affecting the connector or contaminating the fluid.
Harold Kruger Instruments 3195

Quick-Release Hook—A quick-release hook with 6000-lb capacity has been announced. It is intended for lifting and dropping objects that are too heavy or too bulky to be tested on conventional drop testers or incline-impact testers.
L.A.B. Corp. 3196

Timer—The Tecam gelation timer is used for determining the gelation time ("pot-life") of synthetic adhesives, silica sols, drying oils, plastics, and other liquids that gel. Gelation time is a characteristic of certain substances that is significant in production control, as well as for the subsequent behavior of the material in the customer's hands.
Arthur S. LaPine & Co. 3197

C-Band Transmitter System—Essentially a self-contained power amplifier of compact design, the new Levinthal Model 208T can be utilized with various klystrons to cover an extensive frequency range. For example, with the Varian VA804 klystron, it covers a band 4400 to 5875 Mc; with the VA805, 5875 to 6425 Mc; and with the VA806, 7125 to 8500 Mc.
Levinthal Electronic Products 3198

Lab Clamps—Posi-Grips have been designed for manipulating laboratory and industrial materials too hot or dangerous to carry by hand. Expertly and scientifically engineered, Posi-Grips' interchangeable heads are adaptable to a large assortment of tasks.
Machine & Instrument Design Corp. 3199

Dynamic Balancer—A new, low-cost, high-sensitivity, bench-model dynamic balancer which uses a seismic, velocity-type pickup to assure rugged, maintenance-free operation is announced. This unit, the MU-6, combines compact ruggedness with a very minimum of mounting problems and with extreme simplicity of operation.
Micro Balancing, Inc. 3200

Oscillograph—Model 603 oscillograph provides for the recording of up to 50 channels of test data on a 12-in. wide record. Record speeds, variable from 0.05 to 170 in. per sec, allow engineers to select the best operational condition for recording a particular test event.
Midwestern Instruments 3201

Calibrating Machine—Redesign of the yoke of the Morehouse load cell calibrating machine to add motorized or mechanical adjustment has been announced.
Morehouse Machine Co. 3202

Air Monitor—New air monitor AM-3A features four interchangeable detectors, including one said to be three times as sensitive as any other now commercially available. By choice of detector, the monitor is able to sense any of four combinations of radioactivity: (1) alpha beta and gamma, (2) beta-gamma, (3) alpha, or (4) beta.
Nuclear Measurements Corp. 3203

Corona Test Set—An improved Model CT10-0.2 corona test set features a small, portable, self-contained unit for nondestructive evaluation of insulation quality. The high-sensitivity corona detection conforms to MIL, ASTM, and IPCEA standards.
Peschel Electronics, Inc. 3204

Optical Comparator—A new line of optical comparators is being introduced for use in quality inspection of precision products throughout industry.
Projecto-Graph Instruments Corp. 3205

X-Y Recording—X-Y recording of phenomena far beyond the limits of electromechanical plotters is now possible with a new X-Y recorder which uses optical galvanometers, a light beam trace and immediate-developing, direct-print paper charts.
Sanborn Co. 3206

Soil Penetrometer—The bearing capacity of cohesive soils can now be determined rapidly in the field using the new model CL-700 pocket penetrometer.
Soiltest, Inc. 3207

Mixer—The Spex mixer mill, an impact grinder and mixer, has been extensively redesigned. Vibration and noise have been reduced to a minimum through the use of

(*Continued on next page*)

Gaertner Dilatation Interferometer

measures thermal expansions of as little as 0.0000025 cm.

For extremely precise measurement of coefficients of thermal expansion for small metallic, ceramic or plastic specimens at temperatures up to 1000° C.

Using mercury light, changes of 0.0000025 cm. can be accurately determined with this convenient, reliable instrument. It is especially useful in comparing dilatation curves of materials which are to be fused together, such as metal and glass, metal and vitreous enamel, etc.

Model I-1118tl (above) consists of Interferometer Plates and Windows, Viewing Apparatus, Furnace and Control, Potentiometer Pyrometer mounted on panel, and Lamp.

Write for newly published Bulletin 140-58

The Gaertner Scientific Corporation

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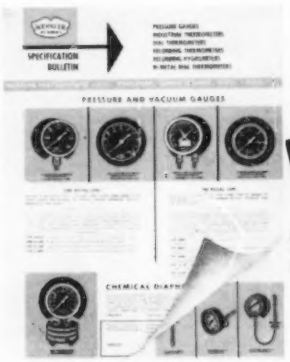
CIRCLE 319 ON READER SERVICE CARD



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- Bi-Metal Dial Thermometers

Engineers, architects and contractors are finding this Weksler Specification Bulletin a great time saver!

Designed for "at a glance" information and specifications on Weksler instruments most frequently specified for indicating and recording temperature, pressure and humidity, the bulletin illustrates and describes most of the basic instruments needed in air-conditioning, heating, ventilating, plumbing and piping.

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FREEPORT, L.I., NEW YORK
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CRCLE 320 ON READER SERVICE CARD

Laboratory Items

internal shock mounts and a thick plastic finish on the case.
Spex Industries, Inc. 3208

Tensile Tester—A new vertical bench-mounted tensile tester, capable of performing compression tests, has been developed. Designated Model TE-10, this tester operates hydraulically and is designed for simple operation, high accuracy, and minimum bench space.
Steel City Testing Machines, Inc. 3209

Tension Meter for Sheets—Web tension meter features quick trigger insertion and cylindrical rollers without front flanges. Insertion can easily be made in the side of a moving sheet. By cocking the trigger (like a gun) the two outer guide rollers are lowered. The tension meter is then inserted into the side of the sheet, web, or selvage and the trigger released. This returns the outer reference rollers to test position where they lift the sheet against the sensing roller in the center. The latter is linked to a mechanical gear train which rotates an indicating hand over a dial facing the observer.
Tensitron, Inc. 3210

Container & Package Tester—Container compression, stacking, and manufacturer's joint tests are performed on the Model TM49005 tester. It accommodates specimens as large as 36 by 48 by 72 in. and has two strength ranges of 0 to 2000 lb and 0 to 10,000 lb.
Testing Machines, Inc. 3211

Control Amplifier—A new, compact, relay-control amplifier with a sensitivity of 1 μv and stability of ± 1 μv is announced. This amplifier is claimed to perform excellently as a component in instruments of laboratory accuracy and to maintain its operating characteristics even where electrical interference, extreme variations in power supply, and high external input resistance are present.
Thermo Electric Co. 3212

Sample Cutter—The new platform and guide used with the JDC precision sample cutter for preparing paper, textile, rubber, plastic films, and light metal samples eliminates the necessity of having two cutters. All existing JDC cutters can be changed to cut both Elmendorf and tensile tester samples.
Thwing-Albert Instrument Co. 3213

Hydraulic Press—A new 50-ton hydraulic laboratory press featuring more convenient working height is introduced. Electrically heated flat-ground platens are 12 by 15 in. They can be furnished drilled for steam or for water cooling.
Wabash Metal Products Co. 3214

CATALOGS & LITERATURE

Thermocouple Connector—*Data Sheet F* describes a new type of high temperature thermocouple connector that features direct contact of the thermocouple lead wire to the wire of the thermocouple. It is mounted on the end of the thermocouple shaft, swaged ceramic-insulated wire, by means of a brass compression fitting. No welding is required; will operate to 1000 F.
Aero Research Instrument Co. 6109

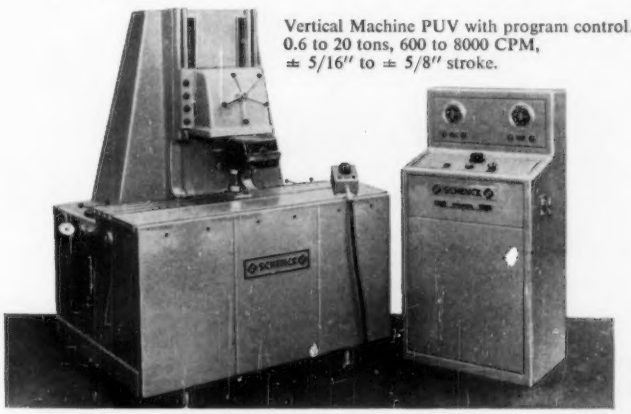
(Continued on page 98)

Multi-Purpose SCHENCK
Fatigue Testing Machines
HIGH SPEED—COMPLETELY ADJUSTABLE FOR RESEARCH AND PRODUCTION TESTING

Exclusive Schenck fatigue testers offer more outstanding features. Test tensile strength, torsion, bending fatigue of any material, soft (rubber-plastics) or hard (steels). Basic push-pull action. High speed cycling permits rapid plotting of S-N curves. Built-in controls provide infinitely variable adjustment for frequency range, static and dynamic loads. Patented optical system measures loads, provides continuous visual inspection. Rubber mounts eliminate special foundations.

Horizontal Machine PB with program control.
3 to 100 tons, 280 to 4500 CPM, ± 1″ to ± 2″ stroke.

The Schenck PB horizontal (above) with long stroke and additional low speed drive applies rapid stress reversals with high loads—provides closest possible simulation of operating conditions. The Schenck PUV vertical (below) features many exclusives capacities of PB, but saves space through vertical design which makes it the ideal laboratory testing machine.



Vertical Machine PUV with program control.
0.6 to 20 tons, 600 to 8000 CPM,
± 5/16″ to ± 5/8″ stroke.

Schenck horizontal type PP (not illustrated).
2 to 60 tons, 2000 to 2600 CPM, ± 3/16″ to ± 9/32″ stroke.

Various gripping devices, load multipliers, heating-freezing chambers and program controls available for most, if not all, models.

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COSA *nationwide sales and service of precision machine tools —from bench lathes to boring mills.*

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FOR FURTHER INFORMATION CIRCLE 321 ON READER SERVICE CARD

Catalogs & Literature

(*Continued from page 97*)

Test Instrument Catalog—A new 24-page catalog listing the complete Bruel & Kjaer line of integrated instruments for automatic measurement of sound, vibration, and strain has been announced.
B & K Instruments, Inc. 6110

Spectrophotometer—*Bulletin* 739 includes high-resolution infrared spectra, significant features of the IR-7 infrared spectrophotometer, performance specifications, accessory sample handling data, and applications information.
Beckman Scientific and Process, Instruments Div. 6111

Films of Vibration Tests—Literature describes the Camera-Sync system—a unique means of producing slow-motion movies of vibration tests using normal film speeds. System employs stroboscopic illumination and a pulse camera, both synchronized with the vibration. Shows performance of all parts of a specimen, allowing detailed study of potential and actual failures.
Chadwick-Helmuth Co. 6112

Ultrasonic Cleaning—A newly published booklet, *Tips on Ultrasonic Cleaning*, is being offered. The 12-page booklet includes a simplified explanation of the basic principles of ultrasonics.
Circo Ultrasonic Corp. 6113

General Catalog—An entire line of dynamic-measuring and recording instruments including oscillographs, data amplifiers, and bridge balances are described in a 16-page catalog, *Bulletin 1310*.
Consolidated Electrodynamics Corp. 6114

Lab Catalog—CSI *Catalog No. 59A* contains illustrations and brief descriptions of 73 testers or equipments manufactured as standard products.
Custom Scientific Instruments, Inc. 6115

Density Measurement—A 12-page booklet on heavy liquids is being offered. Both aqueous and organic liquids are described, and for the higher ranges suspensions of mercury in a heavy liquid. These heavy liquids are useful for the identification of many substances including plastic and are especially useful in quality control of ceramics and glass. They are also used in various instruments.
Engineered Materials 6116

Vibration Interferometer—*Bulletin No. 204-59*, describing the vibration interferometer is now available. It is especially designed for extremely precise checking and calibration of accelerometers.
The Gaertner Scientific Corp. 6117

Laboratory Catalog—A new 6-page, short-form catalog describing and illustrating 20 instruments, including some of the latest products, has been prepared for electronic, physical, and chemical measurement instruments.
Wayne Kerr Corp. 6118

Laboratory Catalog—A 48-page LaPine apparatus *Review No. 10*, features the new line of Freas ovens, incubators, sterilizers, and special purpose cabinets.
Arthur S. LaPine & Co. 6119

Computer Booklet—Factors of application of the newest, all-transistorized, electronic computer system to scientific problems are described in a new booklet. It outlines the speeds, capacities, and over-all performance qualifications of the Honeywell 800 system and gives specific examples of how its design logic and other features contribute to its use and economy in scientific computation.
Minneapolis-Honeywell Regulator Co. 6120

Radioactivity Monitoring—New 16-page *Bulletin M-59*, describing monitoring systems for detecting, measuring, and recording radioactivity, is offered. Included are seven particulate monitoring systems, five detectors, a portable air and area monitor, and a diagram of a typical remote monitoring system for a reactor site.
Nuclear Measurements Corp. 6121

Density Measuring Controller—New 2-page *Bulletin LSG*, describes the method of operation, specifications, and advantages of the Ohmart Model LSG gamma radiation gage which can be used to maintain, at optimum output density, products from equipment such as evaporators, thickeners, dryers, and raw mills.
The Ohmart Corp. 6122

Torsion Testing—A complete line of torsion testing machines is described in a 10-page *Bulletin No. 58*.
Tinius Olsen Testing Machine Co. 6123

Electronic Amplifier—An electronic servo amplifier and power supply for use in a-c instrument servo systems is described in a new technical data sheet.
Seneca Falls Machine Co. Electronics Div. 6124

Inspection Light—Lite-Mite descriptive folder illustrates use of inspection lamp. Consists of fluorescent lamp and attached magnifying lens.
Stocker & Yale, Inc. 6125

Plastics Catalog—Polyethylene, Teflon, and other plastic laboratory ware is described in 24-page *Bulletin No. 114-A*. This new bulletin illustrates and describes 406 items of laboratory ware. Also included is information as to the physical and chemical properties of the various plastics and the purposes for which they are suitable.
Arthur H. Thomas Co. 6126

Instrument Catalog—A 4-page catalog describing and listing specifications for the new Thermo Electronic signaling controller is now available.
Thermo Electric Co., Inc. 6127

YSI THERMISTEMP®
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BASED
TEMPERATURE MEASUREMENT

- REMOTE READING IN °F AND °C.
- RANGES FROM −50° TO +300° F (−45° TO +150° C).
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NEWS OF LABORATORIES

Ambric Testing and Engineering Associates, Inc., Philadelphia, Pa.—Announce the opening of their new testing laboratories at 4041 Ridge Ave., Building 11, Phila. 29, Pa. The laboratory is fully equipped and staffed to perform physical tests and chemical analyses of structural and mechanical materials. These include concrete, steel, masonry materials, soils, paints, fuels, and bituminous materials. The laboratories are directed by Harold M. Carson, president; Donald D. Meisel, chief engineer; and Lewis G. Bricker, chief chemist, all of whom have been engaged as consultants in this field for many years.

International Testing Laboratories, Inc., Newark, N. J.—Latest brochure describing complete facilities of an independent commercial testing laboratory now available for distribution upon receipt of request on company letterhead. Address Dept. H, International Testing Laboratories, Inc., 580 Market St., Newark, N. J.

New High Power Pulsed Oscillator

PG-650-C

The successful introduction of the PG-650 Pulsed oscillator to many test applications has led to an improved model of interest to workers in ultrasonics, r.f. transient analysis, nuclear magnetic resonance, etc. The following characteristics and features are available only with the PG-650-C.

Frequency Coverage.....5-90 MC in 7 ranges*
R. F. output Voltage (Min.)
into 93 ohms.....0-300 p. to p.
Pulse length continuously variable....1½-15 usec
Rise and Fall times (Max.).....0.3 usec
Pulse Droop.....5% Max.
Noise Output between Pulses
.....Thermal Noise from Termination
Harmonic Content (Max.) mostly 3rd..10%
R. F. Leakage.....Negligible
Trigger to Pulse Jitter.....005 usec
P. R. F. External.....0-3000 cps
P. R. F. Internal.....50-2500 locking on 60
Pulse to Pulse Jitter (Max.).....005 usec

SPECIAL FEATURES
Internal Delay Ranges available from calibrated Helipot. . .200, 1100, 11,000 usec
Gate Pulse output available for intensifying and blanking purposes
External modulation of r.f. oscillator using varying pulse lengths and p.r.f's for Carr-Purcell Method.
Fine controls of P.R.F., pulse length, and delay times.

***Use of special coils will extend the coverage from 0.5 to 150 MC**

Please write for our bulletins on other test equipment: Wide Band Amplifiers, Preamplifiers, and Precision Attenuators.

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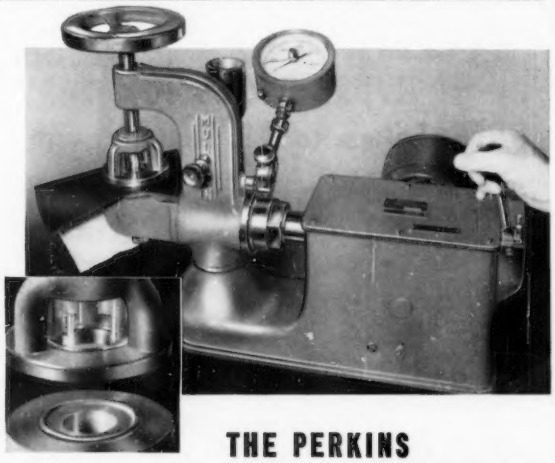

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For water penetration tests on water proofed fabrics. Tests either flat cloth or seams.
Also tests bursting strength of plastic films.
Available with hand or motor drive.

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the wide line that lets you select the exact type and size you need for your own specific applications

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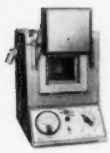

Type 1500

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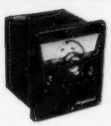
A wide range of sizes to serve almost any critical or routine laboratory need.



Amplitrol Controller

TEMPERATURE CONTROLLERS

Electronic pyrometer controllers and semi-automatic input controllers for most laboratory requirements.

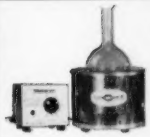
Type 1900

TEMCO ELECTRIC HOT PLATES

Provide extremely close control of temperature. All models have stainless steel cases and are scientifically ventilated.

TEMCO STIR-PLATE

This popular combination magnetic stirrer and hot plate provides a wide range of closely controlled temperature and stirring speed.



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One unit with interchangeable baskets handles several flask sizes. Rugged, safe, dependable.

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For accurate and convenient measurement of temperature and direct-current millivolts.

Choose TEMCO products with confidence. Many thousands are in use the world over. Write for free TEMCO-THERMOLYNE catalog information and name of nearest dealer.

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CIRCLE 325 ON READER SERVICE CARD

Federal Government Standards Index Changes

THE FEDERAL Supply Service of the General Services Administration is charged with the responsibility for establishing specifications to be used by the Federal Government for Procurement of materials and supplies. The GSA issues an annual Index of Initiation of Federal Specifications Projects, and monthly supplements.

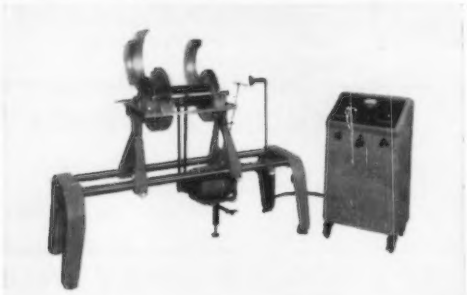
The items listed below appeared in Supplements 3 and 4 for May and June, 1959.

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Class	Assigned Agency & Preparing Activity
(Supplement 3, May, 1959)				
Ammonia, Anhydrous (Compressed)	Rev.	O-A-445a	6830	DOD-Army-CE
Ammonium Hydroxide, Technical	Am. 1	O-A-451d	6810	GSA-FSS
Brass, Leaded and Non-Leaded; Plate, Rolled Bar, Sheet, and Strip	Rev.	QQ-B-613a	9535	DOD-Army-Ord
Brass, Leaded and Non-Leaded; Rods, Shapes, Forgings and Flat Products with Finished Edges	Rev.	QQ-B-626a	9535	DOD-Army-Ord
Butyl Alcohol, Secondary (for Use in Protective Coating)	Rev.	TT-B-848b	6810	GSA-FSS
Butyl Acetate, Secondary (for Use in Protective Coating)	Rev.	TT-B-840b	6810p	GSA-FSS
Cable, Power, Electrical (Flexible Cord and Fixture Wire)	Am. 2	J-C-90a	6145	GSA-FSS
Calcium Hydroxide-Barium Hydroxide Mixture	Am. 1	U-C-60	6505	GSA-FSS
Culverts and Underdrains, Corrugated Iron or Steel, Zinc Coated	Rev.	QQ-C-806a	4710	COM-PR
Drums, Fiber, with Recessed Ends	Am.	PPP-D-715	8110	DOD-Army-QMC
Ink, Copying and Record	New	TT-I-00521a (GSA-FSS)	7510	GSA-FSS
Ink, Marking, Indelible, Black, for Fabrics	New	TT-I-00542b (GSA-FSS)	7510	GSA-FSS
Ink, Numbering Machine	New	TT-I-00540a (GSA-FSS)	7510	GSA-FSS
Insulation, Thermal, Polystyrene, Expanded	New New	HH-I-575 HH-I-00575 (GSA-FSS)	5640	GSA-FSS
Lining, Friction (Clutch and Brake; Metallic and Semi-metallic)	New	KKK-L-370c KKK-L-00370b (GSA-FSS)	25	GSA-FSS
Linings, Brake (Automotive-Use)	Rev. Rev.	HH-L-361d HH-L-00361c (GSA-FSS)	2530	GSA-FS
Thinner, Paint, Odorless, Volatile Mineral Spirits	New	TT-T-295a	8010	GSA-FSS
(Supplement 4, June, 1959)				
Cements, Hydraulic; Sampling, Inspection, and Testing	New	Fed. Test Method Std. 158 (Int. Change Notice 1)	5610	COM-NBS
Anti-Seize Compound, White Lead Base, General Purpose (for Threaded Fittings)	New New	TT-A-580a TT-A-00580 (GSA-FSS)	8030	GSA-FSS
Floor Covering, Vinyl Plastic	Rev.	L-F-00450 (Rev. IFS L-T-751)	7220	COM-NBS
Ink, Writing, Colored (Non-Permanent)	New	TT-I-00549b (GPO)	7510	GSA-FSS
Insecticide, Chlordane (Concentrate, Water Emulsifiable)	New	O-I-515 & O-I-00515 (Navy-Ships)	6840	DOD-Navy-Ships
Linings, Brake (Automotive-Use)	Int. Am. 1	HH-L-00361c	2530	GSA-FSS

Balances Rotors from 2 to 600 lbs.

Turbines, Impellers. Aircraft accessories, Armatures, Pulleys, Drums, etc., may be quickly and accurately balanced with the new Micro Balancing Model SU-7 Dynamic Balancer.



Here in one simple, most versatile, relatively low-cost machine, is the answer to 95% of balancing problems encountered in industry!

Occupies minimum space . . . needs minimum fixturization . . . requires no foundations or hold downs . . . easy to operate and maintain . . . handles large swing diameters . . . meets Mil/Spec B-25511 (USAF) and JIC Standards.

Write for Bulletin SU-7 for details.

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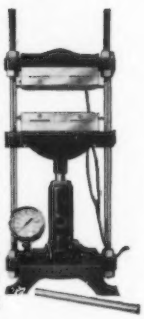
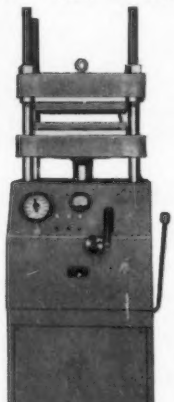
Every model is ruggedly constructed for a long service life and has features found only on Wabash Presses. Surface ground platens are heated with temperature range of 90 to 600° F. Pressure is easy to apply, easy to release. Can be used for pressing, forming, crushing, extruding, filtering, extracting laminating, molding and other operations An indispensible tool for research, inspection and testing. Larger models available motorized. Also specially engineered units for particular requirements.



3-TON PRESS. MODEL 3-8.



50-TON PRESS. MODEL 50-15.

SEND FOR CATALOG

Wabash Metal Products Co.

1571 Morris St., Wabash, Indiana

CIRCLE 327 ON READER SERVICE CARD

Pipe and Pipe Fittings, Soil, Cast Iron	Rev.	WW-P-401a	4710	COM-OTS
Pipe, Asbestos-Cement, Underdrain, Perforated	New	SS-P-340	5630	COM-PR
	New	SS-P-00340		
Plastic Sheet, Laminated (Thermosetting Resin)	New	L-P-508	9330	GCA-FSS
Soap, Surgical, Cake and Liquid	New	P-S-615	6505	DOD-Navy-MMSA
Tile, Floor, Vinyl-Asbestos	New	L-T-345 (Rev. in part IFS L-T-751)	7220	COM-NBS

WITHDRAWALS

Title of Specification	Type of Action	Symbol or Number	Assigned Agency or Technical Committee	Reason for Withdrawal
(Supplement 3, May, 1959)				
Carpets and Rugs, Axminster	Rev.	DDD-C-51b	DOD-Navy-Y&D	Withdrawn from Navy (Y&D) and reassigned to GSA-FSS
Carpets and Rugs, Wilton	Rev.	DDD-C-71b	DOD-Navy-Y&D	Withdrawn from Navy (Y&D) and reassigned to GSA-FSS
Hydrazine Sulfate	New	O-H-730	DOD-Navy-Aer.	Limited requirement
Hydroxylamine Hydrochloride	New	O-H-915	DOD-Navy-Aer.	Limited requirement
Potassium Sodium Ferricyanide	New	O-P-575	DOD-Navy-Aer.	Limited requirement
Potassium Thiocyanate	New	O-P-590	DOD-Navy-Aer.	Limited requirement
Sodium Thiocyanate	New	O-S-670	DOD-Navy-Aer.	Will be included in O-C-275 when issued

PROMULGATIONS

Title	Type of Action	Symbol or Number
(Supplement 3, May, 1959)		
Calcium Hydroxide-Barium Hydroxide Mixture	New	U-C-60
Molding, Plastic, Polystyrene	Am. 2	L-M-520
Paint (Titanium-Zinc and Oil, Exterior, Fume-Resistant, Ready-Mixed, White)	Am. 2	TT-P-103
Paper, Toilet Tissue (Superseding UU-P-00556e & UU-P-556c)	Rev.	UU-P-556f
Pipet, Serological (Folin-Wu) (Superseding DD-P-00495b(FEW-PHS) & DD-P-395a)	Rev.	DD-P-395c
Rags, Wiping, Cotton	Am. 2	DDD-R-30
Rivets, Solid, Small; Rivets, Tubular, Small; and Caps, Rivets, General Purpose	Rev.	FF-R-556a
Sheathing Board, Gypsum	Am. 3	SS-S-276
Silver Plating, Electrodeposited; General Requirements for (Superseding QQ-S-365)	Rev.	QQ-S-365a
Wire, Steel, Alloy (General Purpose Quality), for Mechanical Springs (Superseding QQ-W-474a (In Part))	New	QQ-W-412
Wire, Steel, High Carbon, Round, Uncoated, for Mechanical Springs (General Purpose) (Superseding QQ-W-465a & QQ-W-474a (In Part))	New	QQ-W-428
(Supplement 4, June, 1959)		
Aluminum Bronze, Plate, Bar, Sheet, and Strip (Superseding QQ-B-667)	New	QQ-A-620
Calcium Hydroxide-Barium Hydroxide Mixture	Am. 1	U-C-60
Cloth, Cotton, Corduroy (Superseding CCC-C-591)	New	CCC-C-441
Cloth, Cotton, Seersucker (Superseding CCC-C-00448)	New	CCC-C-448a
Copper-Nickel-Zinc Alloy; Rod, Shapes, and Flat Products With Finished Edges (Flat Wire, Strip, and Bar)	Rev.	QQ-C-586a
Molding Plastic, Polystyrene, Modified	Am. 1	L-M-525
Molding Plastic, Polyvinyl Chloride, Rigid	Am. 1	L-M-530a
Wax, General Purpose, Solvent Type (Superseding P-W-00158a(GSA-FSS) & P-W-158)	Rev.	P-W-158b
Zinc Coating, Electrodeposited, Requirements For	Rev.	QQ-Z-325a

INTERIM FEDERAL SPECIFICATIONS AND STANDARDS ISSUED

Title of Specification	Type of Action	Symbol or Number
(Supplement 3, May, 1959)		
Soap, Toilet (Floating White)	Rev.	Int. Fed. Std. 0010b (GSA-FSS)
Butyl Acetate, Secondary (For Use in Organic Coatings)	New	TT-B-00840a(GSA-FSS)

TESTING MACHINES, INC.

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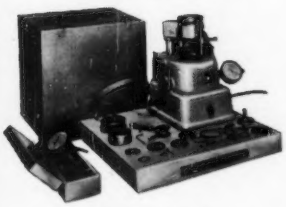

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Butyl Alcohol, Secondary (For Use in Organic Coatings)	New	TT-B-00848a(GSA-FSS)
Calcium Hypochlorite, Technical Chlorinated Lime, Technical	Am. 1	O-C-114a (Ships)
Cement, Masonry	New	SS-C-00181d (COM-NBS)
Cements, Portland	New	SS-C-00192c (COM-NBS)
Cements, Portland, Blast-Furnace Slag	Rev.	SS-C-00197a (COM-NBS)
Conduit, Electrical, Aluminum, Rigid	New	WW-C-00540 (GSA-FSS)
Paint, 1200-Degree Heat-Resisting	Am. 1	TT-P-0028 (Navy Ships)
Pigment, Chrome-Yellow and Chrome-Orange, Dry	Rev.	TT-P-00346 (GSA-FSS)
Soap, Toilet (Floating White)	Am. 1	P-S-616d (Ships)
Thinner, Paint, Odorless, Volatile Mineral Spirits	New	TT-T-00295 (GSA-FSS)
(Supplement 4, June, 1959)		
Disinfectant, Germicidal and Fungicidal, Concentrate	Am. 1	O-D-406 (Ships)
Fabrics, Upholstery	Am. 1	CCC-F-66a (GSA-FSS)
Hydrogen	Am. 1	BB-Y-886 (Ships)
Ink, Copying and Record	New	TT-I-00521a (GPO)
Ink, Numbering Machine	New	TT-I-00540a (GSA-FSS)
Insulation, Thermal, Polystyrene, Expanded	New	HH-I-00575 (GSA-FSS)
Lights, Household	Am. 2	W-L-314a (GSA-FSS)
Lining, Friction (Clutch and Brake, Metallic and Semi-Metallic)	Rev.	KKK-L-00370b (GSA-FSS)
Linings, Brake (Automotive-Use)	New & Am. 1	HH-L-00361c (GSA-FSS)
Paulins, Fire, Water, Weather and Mildew-Resistant	New	K-P-00146a (Army-QMC)
Pipe and Pipe Fittings, Soil, Cast Iron	New	WW-P-00401a (COMM-OTS)
Sodium Phosphate, Dibasic, Anhydrous	Am. 2	O-S-639 (Navy-Ships)
Tube, Copper, Seamless (For General Use)	New	WW-T-00775 (Navy-Ships)
Zinc, Sheet and Strip	Am. 2	QQ-Z-301b (Ships)

PURCHASE DESCRIPTIONS ISSUED

Title	Type of Action	Number
(Supplement 3, May, 1959)		
Concentrated Heavy Duty Synthetic Liquid Detergent	New	P-2-7
(Supplement 4, June, 1959)		
Liquid Disinfectant-Detergent (Iodophor)	New	P-2-8

CANCELLATIONS

Title	Symbol or Number	Reason for Cancellation
(Supplement 3, May, 1959)		
Soap, Chip	P-S-566b	Superseded by Fed. Spec. P-S-580a
Wire, Steel (Carbon and Alloy), Spring, Oil-Tempered and Annealed	QQ-W-474a	Superseded by Fed. Specs. QQ-W-412 and QQ-W-428
Wire, Steel (Carbon), Hard-Drawn, Spring and Zinc-Coated, High Strength	QQ-W-465a	Superseded by Fed. Spec. QQ-W-428
(Supplement 4, June, 1959)		
Cadmium-Yellow (Cadmium Lithopone), Dry (Paint-Pigment)	TT-C-0083a	Superseded by TT-P-342
Chrome-Yellow and Chrome-Orange, Dry (Paint-Pigment)	TT-C-00290a	Superseded by TT-P-00346 (GSA-FSS)
Continuous Identification Marking of Iron and Steel Products	Int. Fed. Std. 00133	Superseded by Fed. Std. 183
Corduroy, Cotton	CCC-C-591	Superseded by CCC-C-441
Flooring, Hardwood Block	NN-F-476	Superseded by NN-B-350
Sienna, Burnt and Raw, Dry (Paint-Pigments)	TT-S-00346a	Superseded by TT-P-435

SPECIFICATIONS AND STANDARDS APPROVED FOR PRINTING

Title of Specification	Type of Action	Symbol or Number
(Supplement 3, May, 1959)		
Continuous Identification Marking of Iron and Steel Products	New	Fed. Std. No. 183
Metals, Test Methods	Rev.	Fed. Test Method Std. No. 151a
Metals, Test Methods	Not. 1 to Supp. A	Fed. Test Method Std. No. 151a
Metals, Test Methods	Not. 1 to Supp. B	Fed. Test Method Std. No. 151a

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INDEX TO ADVERTISERS

ARENBERG ULTRASONIC LABORATORY, INC 99
ATLAS ELECTRIC DEVICES CO 72

B & H INSTRUMENT CO., INC. 87, 90
BALDWIN-LIMA-HAMILTON CORP. 2, 81
BLUE M ELECTRIC CO. 102
BRANSON INSTRUMENTS, INC. 92
BUDD NUCLEAR SYSTEMS
A DIVISION OF THE BUDD COMPANY 79
BUEHLER LTD. 89
BURRELL CORP. 67

CADY & CO., E. J. 77
CENTRAL SCIENTIFIC CO. 77, 78, 80
COSA CORP. 97
CUSTOM SCIENTIFIC INSTRUMENTS, INC. 91

DELTA CHEMICAL WORKS, INC. 80

EASTMAN KODAK CO. 65
EBERBACH CORP. 93

FISHER SCIENTIFIC CO. 84
FORNEY'S INC., TESTER DIVISION 103

GAERTNER SCIENTIFIC CORP. 96
GENERAL RADIO CO. . . . . Inside Back Cover
GRAPHIC SYSTEMS 78
GRIES INDUSTRIES, INC. 93

HEITZ, KARL, INC. 77
HEVI-DUTY ELECTRIC CO. 76
HIRSCHMANN CO., INC., CARL 68, 69
HOGGSON & PETTIS MFG. CO. 66

INSTRON ENGINEERING CORP. . . . . Inside Front Cover
INSTRUMENTS FOR RESEARCH AND INDUSTRY 95

KLETT MFG. CO. 82

LACLEDE STEEL CO. 83

METTLER INSTRUMENT CORP. 75
MICRO BALANCING, INC. 100

OLSEN TESTING MACHINE CO., TINIUS
Outside Back Cover
OZONE RESEARCH AND EQUIPMENT CORP. 74

PARR INSTRUMENT CO. 82
PERKINS & SON, INC., B. F. 99
PLAS-TECH EQUIPMENT CORP. 71

RIEHLE TESTING MACHINES
A DIVISION OF AMERICAN MACHINE AND METALS, INC. 86

SARGENT & CO., E. H. 73
SCOTT TESTERS, INC. 3
SHORE INSTRUMENT & MFG. CO., INC. 102
SIEBURG INDUSTRIES INC. 77
SMS INSTRUMENT CO. 103
SOILTEST, INC. 70
SYNTRON CO. 88

TATNALL MEASURING SYSTEMS CO.
A SUBSIDIARY OF THE BUDD COMPANY 4, 85
TESTING MACHINES, INC. 101
THERMO ELECTRIC MFG. CO. 99
THOMAS CO., ARTHUR H. 93
THWING-ALBERT INSTRUMENT CO. 94

UNITRON INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO. 104

WABASH METAL PRODUCTS CO. 100
WEKSLER INSTRUMENTS CORP. 96
WILEY & SONS, INC., JOHN 82

YELLOW SPRINGS INSTRUMENT CO. 98

PROFESSIONAL CARDS 62, 63, 64

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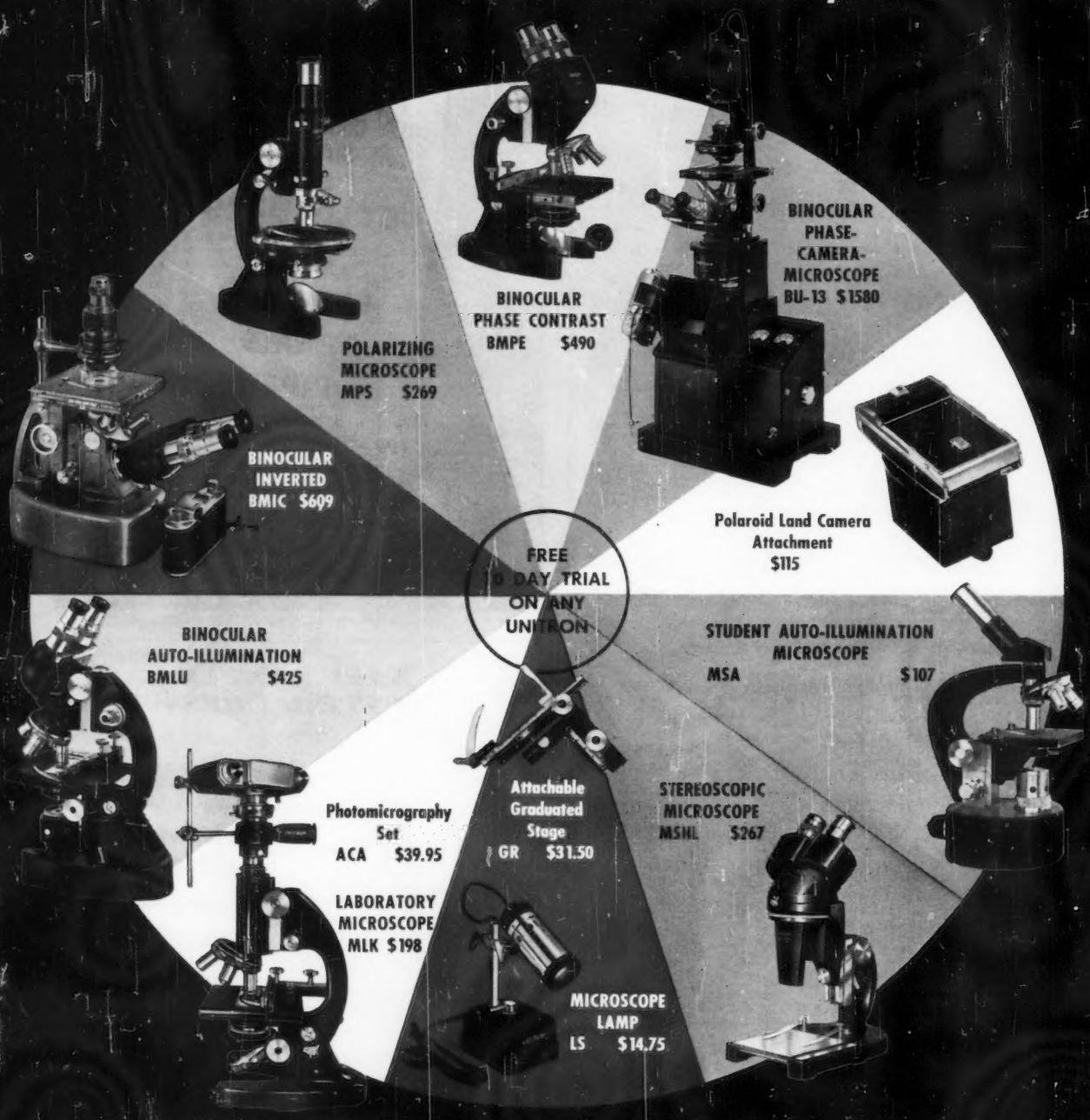
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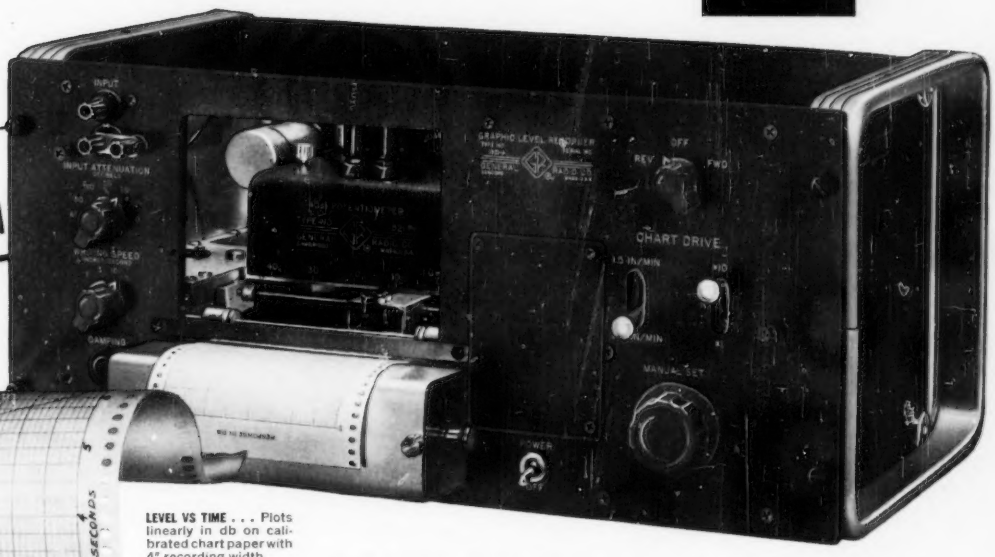
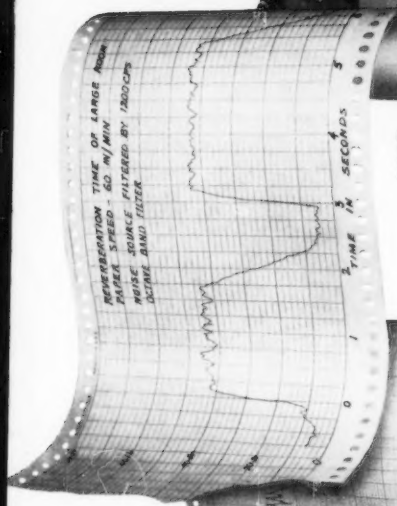
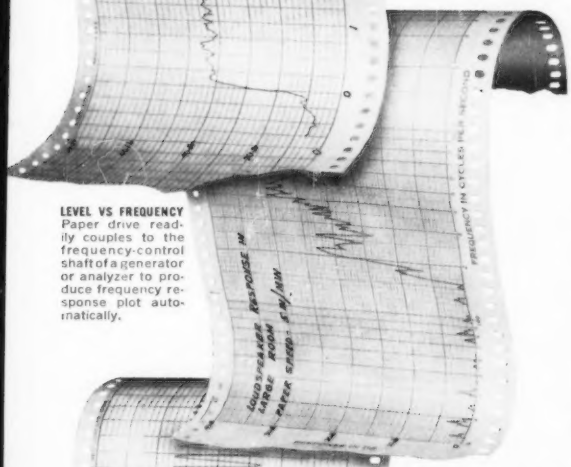


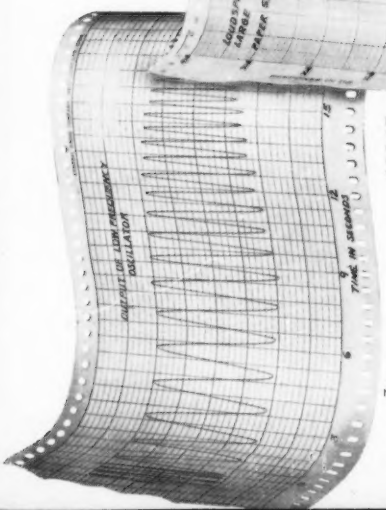


LEVEL VS TIME . . . Plots linearly in db on calibrated chart paper with 4" recording width.

The Type 1521-A Graphic Level Recorder* provides permanent ink records of the response of electronic and electro-acoustical devices as a function of either frequency or time. It can also be used as a linear dc recorder.



LEVEL VS FREQUENCY Paper drive readily couples to the frequency-control shaft of a generator or analyzer to produce frequency response plot automatically.



DC VS TIME . . . Easily converts to a linear dc recorder capable of plotting instantaneous value of waveform from dc to 10 c.

Traces the rms level of ac voltages from 20 cps to 200 kc.

High Sensitivity . . . 1-mv minimum input level, corresponds to 0-db point on chart paper.

Input Ranges . . . 40 db . . . 20-db and 80-db ranges provided by accessory plug-in Potentiometers . . . 0.8v full scale for dc recording, with accessory Linear Potentiometer.

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Rms Response . . . preferable to peak or average response, as it is more nearly independent of input signal waveshape.

Four Pen Writing Speeds . . . 1, 3, 10, and 20 in/sec (10, 30, 100, and 200 db/sec with 40-db Potentiometer) with less than 1-db overshoot.

Four Paper Speeds . . . 2.5, 7.5, 25, and 75 in/min. Accessory slow-speed motor provides speeds from 2.5 to 75 in/hour. Recorder can be driven in reverse as well as forward.

Static Accuracy is better than 1/64" or 0.4% of full scale; fast servo system with low overshoot provides excellent dynamic accuracy.

Input Impedance . . . 10 kΩ for ac level recording, 1 kΩ for dc recording.

Can be either bench or rack mounted.

Drive and Link Units available for coupling to generator or analyzer; chart papers available calibrated linearly, logarithmically, or for use with G-R Sound Analyzer.

*Patent No. 2,581,133

Type 1521-A Graphic Level Recorder with 40-db Potentiometer . . . $995.

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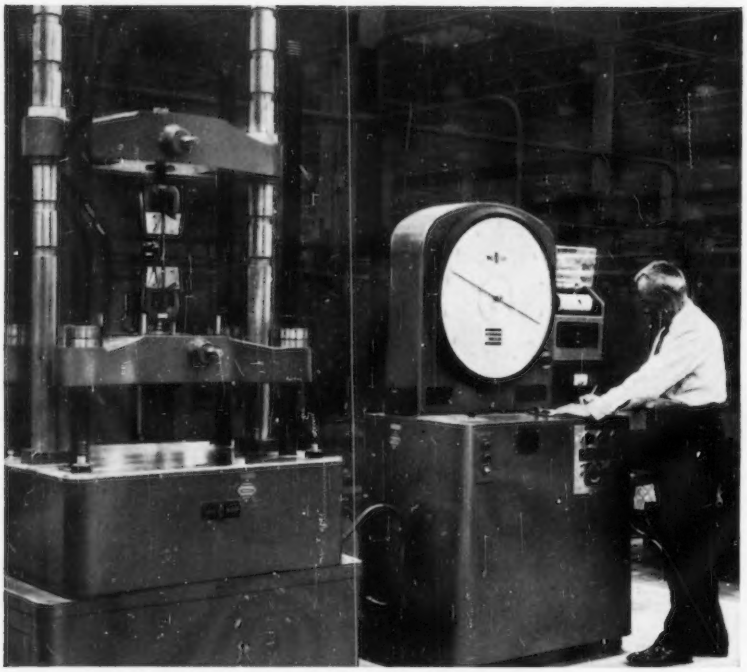

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